PRECISION STRIKE ASSOCIATION

Precision Strike

Technology Symposium

23 - 25 October 2007
****Please note - Many of the presentations were classified or not approved for public release**
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Agenda

Tuesday 23 October 2007

Targeting Session:

- *"Testing Technology and C2 Structure for Third Party Targeting of Tactical Tomahawk"*, ***William Druce,*** PM for Tomahawk Advanced Concepts, JHU/APL
- *"Automatic Targeting Solutions Over Heterogeneous Databases Using Intelligent Agents*", **Mr. Keith Davis,** Integrity Applications Incorporated

Luncheon Address:
"The Future In Long Range Strike", ***Dr. Rebecca Grant,*** President, IRIS Independent Research, Inc & Author of Return of the Bomber

C4ISR Session:
Chair: ***Mr. Buck Buchanan,*** JHU/APL C2 Cross Enterprise Initiative, Director

- *"Results of the Johns Hopkins University Applied Physics Laboratory's C2 Hypotheses Exercise"*, ***Mr. James L. Hillman,*** JHU/APL Group Supervisor, Advanced Concepts & Technology Analysis Group
- *"Can Real-Time Operation a Services-Oriented Architecture (SOA) Environment"*, ***Mr. Charles G. Kille***, Principal Systems Engineer, Raytheon Company

Wednesday, 24 October 2007

Luncheon Address:
"Enabling Emerging Technologies and Technical Solutions For Protecting Our Nation", ***Captain Charles T. "Chuck" Nash,*** USN (Ret.), Fox News Military Pundit & Iran Policy Committee Member; President, Emerging Technologies Int'l

Effects Session:

- *"Naval S&T Strategic Plan – Defining the Strategic Direction for Tomorrow in Power Projection"*, ***Mr. Michael B. Deitchman,*** Deputy Chief of Naval Research, Naval Air Warfare & Weapons S&T Department, Office of Naval Research

"The Way Ahead For Sensor Platforms", ***Colonel Paul Crawford,*** USA, Chief of Force Development for FCS, Army G-8
"Net- Enabled Weapons – Another Node on the Network", ***Captain Mat Winter,*** USN, NAVAIR PMA-201

Precision Strike Technology Symposium (PSTS-07)

Tuesday October 23

AGENDA

Please note - Many of the presentations were classified or not approved for public release

0800 **CHECK-IN / CONTINENTAL BREAKFAST**
Sponsored by: Kaman Fuzing

0900 **SYMPOSIUM WELCOME:** ***Bill Dalecky***
Chairman of the Board (NO Presentation)

0905 **JHU / APL WELCOME:** ***Dr. Bill LaPlante***
Head, JHU/APL Global Engagement Department
(NO Presentation)

0910 **SPECIAL REMARKS:** ***Dr. Michael Vlahos***
JHU/APL (NO Presentation)

0945 **OPENING KEYNOTE ADDRESS—TRANSFORMING THE JOINT FORCE & STRENGTHENING WARFIGHTING CAPABILITIES:** (NO Presentation)
Lieutenant General John G. Castellaw, USMC
Deputy Commandant for Programs and Resources

1030 **NETWORKING REFRESHMENT BREAK**
Sponsored by: Northrop Grumman

1100 **TARGETING SESSION:**
Chair: ***JT Morris***—Vice President, Whitney, Bradley & Brown, Inc.

- **Kill Chain Analysis for Naval Special Warfare (NSW) Weapons, Platforms, and Sensors:** ***Chris Hase***—Defense Analyst, Whitney, Bradley & Brown, Inc. (NO Presentation)
- **Precision Strike UAS Off-board Sensing Capability:** ***James Guthrie***—Defense Threat Reduction Agency
- **Testing Technology and C2 Structure for Third Party Targeting of Tactical Tomahawk:** ***William Druce***—PM for Tomahawk Advanced Concepts, JHU/APL
- **Integrating the Kill Chain in Defense against Rocket, Artillery, Mortar & C-UAVs:** ***P. Kevin Peppe***—Director, Close in Weapons Systems, Raytheon Missile Systems (NO Presentation)

1245 **LUNCHEON**—Kossiakoff Center Dining Room
Sponsored by: Lockheed Martin Company

1330 **LUNCHEON ADDRESS—THE FUTURE IN LONG RANGE STRIKE:**
Dr. Rebecca Grant—President, IRIS Independent Research, Inc. & Author of Return of the Bomber

1400 **C4ISR SESSION:**
Chair: ***Buck Buchanan***—JHU/APL C2 Cross Enterprise Initiative Director

- **Results of the Johns Hopkins University Applied Physics Laboratory's C2 Hypotheses Exercise:** ***James L. Hillman***—JHU/APL Group Supervisor, Advanced Concepts & Technology Analysis Group
- **Can Real-Time Operate in a Services-Oriented Architecture (SOA) Environment:** ***Charles G. Kille***—Principal Systems Engineer, Raytheon Company
- **Applying Service Oriented Architecture to Tomahawk C2 and GWOT:** ***LCDR Andrew Biehn, USN***—DD, Washington Planning Center, NAVAIR PMA-281 (NO Presentation)
- **Benefits of a Precision GPS Ephemeris (PGE) Tactical Control Station (TCS) GPS Web Services for Precision Strike:** ***Dr. Alison K. Brown***—President & CEO, NAVSYS Corp.

1545 **NETWORKING REFRESHMENT BREAK**
Sponsored by: Northrop Grumman

1600 **THE IRAQI PERSPECTIVES PROJECT—THE HISTORY WE DON'T KNOW (ADAPTATION TO PRECISION—IRAQ 1991-2003):**
Kevin Woods—Joint Advanced Warfighting Program & 2006 Goodpaster Award Winner, Institute for Defense Analyses (NO Presentation)

1645 **PRECISION STRIKE INTELLIGENCE CAPABILITIES & TECHNOLOGY IMPROVEMENTS—ENEMY ADAPTATION TO OUR PRECISE WEAPONS TECHNOLOGY:**
L.C. Greenwood—Division Chief, Studies & Analysis Group, Operations Integration Center, Joint IED Defeat Organization (JIEDDO) (NO Presentation)

1730 **EVENING RECEPTION:**
Sponsored by: Orbital Sciences, Inc.

Precision Strike Technology Symposium (PSTS-07)
Wednesday, October 24
AGENDA

0700 **CHECK-IN / CONTINENTAL BREAKFAST**

0745 **ELECTRONIC WARFARE ROADMAP:**
Jay Kistler—Technical Director, Air Warfare, Portfolio Systems Acquisition Directorate, OUSD(AT&L)

0815 **WEAPONS SESSION:**
Chair: Captain Pete Murphy, USN
Air Warfare, Portfolio Systems Acquisition Directorate, OUSD(AT&L)

- **High Speed Strike Weapon Engine Development: Michael Behring**
  Alliant Techsystems, Inc.
- **AARGM – More than DEAD—A Transformational, High-Speed Strike Weapon for the Fleet:**
  Douglas M. Larratt—Business Development for Strike Weapons, ATK (NO Presentation)
- **Technology for Future Rapid Global Engagement: *Dr. Keith Numbers***—Global Strike Leader, Air Force Research Laboratory

1000 **NETWORKING REFRESHMENT BREAK**
Sponsored by: The Boeing Company

1030 **KEYNOTE ADDRESS—CRITICAL TECHNOLOGIES FOR THE LONG WAR:** (NO Presentation)
The Honorable Ronald M. Sega
Former Under Secretary of the Air Force

1115 **THE LONG WAR—CHANGING THE TARGETING LANDSCAPE:** (NO Presentation)

1145 **LUNCHEON**—Kossiakoff Center Dining Room
Sponsored by: ATK

1220 **LUNCHEON ADDRESS—ENABLING EMERGING TECHNOLOGIES AND TECHNICAL SOLUTIONS FOR PROTECTING OUR NATION:**
Captain Charles T. "Chuck" Nash, USN (Ret.)
Fox News Military Pundit & Iran Policy Committee Member; President, Emerging Technologies Int'l

1300 **EFFECTS SESSION:**
Chair: Suzy Kennedy—JHU/APL Kinetic Engagement Program Area Manager

- **Naval S&T Strategic Plan—Defining the Strategic Direction for Tomorrow in Power Projection:**
  Michael B. Deitchman—Deputy Chief of Naval Research, Naval Air Warfare & Weapons S&T Department, Office of Naval Research
- **Engagement of Time Critical Targets with Small Weaponized UAVs:**
  Brian K. Funk—Senior Professional Staff Member, JHU/APL (NO Presentation)
- **Weaponeering for Hard Target Defeat using Large Blast Munitions:**
  Regan E. Burmeister—Senior Engineer, Applied Research Associates, Inc. (NO Presentation)
- **Tactical Tomahawk Block IV Multi-Mission Upgrade:** (NO Presentation)
  Allen P. Gehris Jr.—Tomahawk Weapon System Advanced Strategies Manager, NAVAIR PMA-280

1445 **NETWORKING REFRESHMENT BREAK**
Sponsored by: The Boeing Company

1500 **JOINT AIRBORNE ELECTRONIC ATTACK (JAEA) FOR THE LONG WAR:** (NO Presentation)
Dr. Jeff Heyer—Head, Electronic Warfare Strategic Planning Organization, Naval Research Laboratory

1530 **THE WAY AHEAD FOR SENSOR PLATFORMS:**
Colonel Paul Crawford, USA
Chief of Force Development for FCS, Army G-8

1600 **NET-ENABLED WEAPONS—ANOTHER NODE ON THE NETWORK:**
Captain Mat Winter, USN—NAVAIR PMA-201

1630 **ARMED UNMANNED SYSTEMS PANEL:**
Moderator: Captain Harold "Bud" Bishop, USN
OPNAV, N880C (NO Presentations)

- ***Steven Borden***—Deputy Chief for Joint Attack Munitions Systems, PEO Missiles & Space, U.S. Army
- ***Captain Tony Albano, USN***—N882D3
- ***Lt Col Jim Molinari, USAF***—UAS Task Force

Precision Strike Technology Symposium (PSTS-07)
Thursday, October 25
AGENDA

0715 **CHECK-IN/CONTINENTAL BREAKFAST**

0800 **INTEL UPDATE ON FOREIGN STRIKE WEAPONS:** ***Lauren Nordstrom***—National Air and Space Intelligence Center (NO Presentation)

0830 **HEALTH OF NATO—NATO'S COMPREHENSIVE APPROACH TO OPERATIONS IN AFGHANISTAN AND IRAQ:** ***George Sinks***—NATO Desk Officer, OASD International Security Affairs, USD(Policy) (NO Presentation)

0900 **KEYNOTE ADDRESS—MISSILE DEFENSE AND SPACE HIGHLIGHTS:** ***Lieutenant General Henry Obering III, USAF*** Director, Missile Defense Agency (NO Presentation)

0945 **IDMATS—COUNTERING THE D&D THREAT:** ***Debbie Chen Watson*****—**National Air and Space Intelligence Center (NO Presentation)

1015 **NETWORKING REFRESHMENT BRUNCH:** Sponsored by: Raytheon Company

1100 **EXPEDITIONARY WARFARE & COALITION INTEGRATION:** ***Captain Harold "Bud" Bishop, USN*** OPNAV, N880C (NO Presentation)

1130 **RETAINING OUR NATION'S GLOBAL STRIKE CAPABILITY:** ***Raleigh Durham*****—**Director, Joint Advanced Concepts, OUSD(AT&L) (NO Presentation)

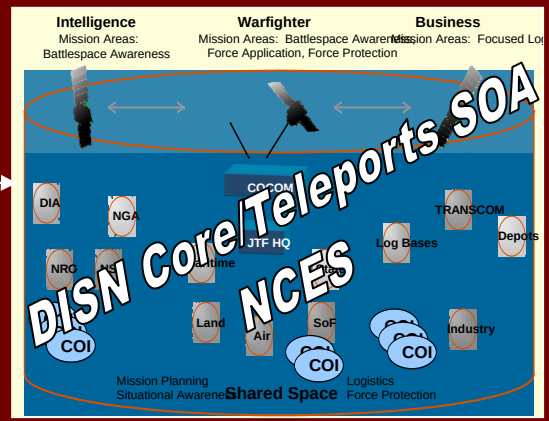
1200 **RELIABLE REPLACEMENT WARHEAD:** ***Sean McDonald***—Special Scientific Advisor, Office of the Deputy Assistant to the Secretary of Defense for NCB/Nuclear Matters (NO Presentation)

1230 **CLOSING REMARKS:** ***Dr. John Walter*** (NO Presentation)

2007 PSTS C4ISR Session

DoD Net-Centric Enterprise Canonical Challenges

Interoperable?



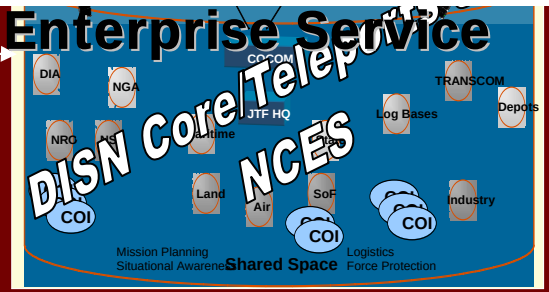
Homeland Security/Intelligence Community/ Coalitions/Allies/NGOs/OGOs/Legacy C2 Systems

DoD Net-Centric Enterprise Canonical Challenges

1. **Rational design of each DoD SOA's 'service-based applications' and 'mission services' to meet warfighing requirements**

2. **Interoperability among at least five DoD Enterprise Service Buses**

Interoperable?



Homeland Security/Intelligence Community/ Coalitions/Allies/NGOs/OGOs/Legacy C2 Systems

Agenda

- Results if the JHU/APL C2 Hypotheses Exercise
  - Jim Hillman (JHU/APL)
- Can Real-Time Operate in a Service-Oriented Architecture (SOA) Environment
  - Charles Kille (Raytheon)
- Applying SOA to Tomahawk C2 and GEOT
  - LCDR Andrew Biehn (NAVAIR PMA-281)
- Benefits of a Precision GPS Ephemeris Tactical Control Station GPS Web Services for Precision Strike
  - Dr. Alison Brown (NAVSYS Corp)

CALL TO DUTY
BOOTS ON THE GROUND

UNITED STATES ARMY






Future Combat Systems (FCS) Enabling Precision

Critical Needs of the Army
A Modernization Strategy That Provides:

Network

Precision Effects

Modern Platform

Greatly Enhanced Capability in Precision Operations

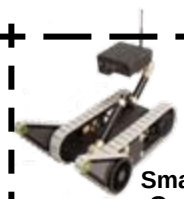
Sustained and Dominant Full Spectrum Landpower

The Four Elements of the Army Modernization Strategy

- **Rapidly field the best new equipment to the current force.**
- **Upgrade and modernize existing systems to ensure all Soldiers have the equipment they need, including:**
  - **Soldiers as a System**
  - **Armored Systems**
  - **Tactical Wheeled Vehicles**
  - **Aviation**
  - **Patriot**
  - **The Network**

- **Incorporate new technologies derived Combat Systems research and development**
- **Field the Future Combat Systems (FCS) Brigade Combat Teams.**

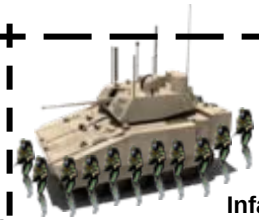
Class I Unmanned Air Vehicle (UAV)



Small Unmanned Ground Vehicle (SUGV)

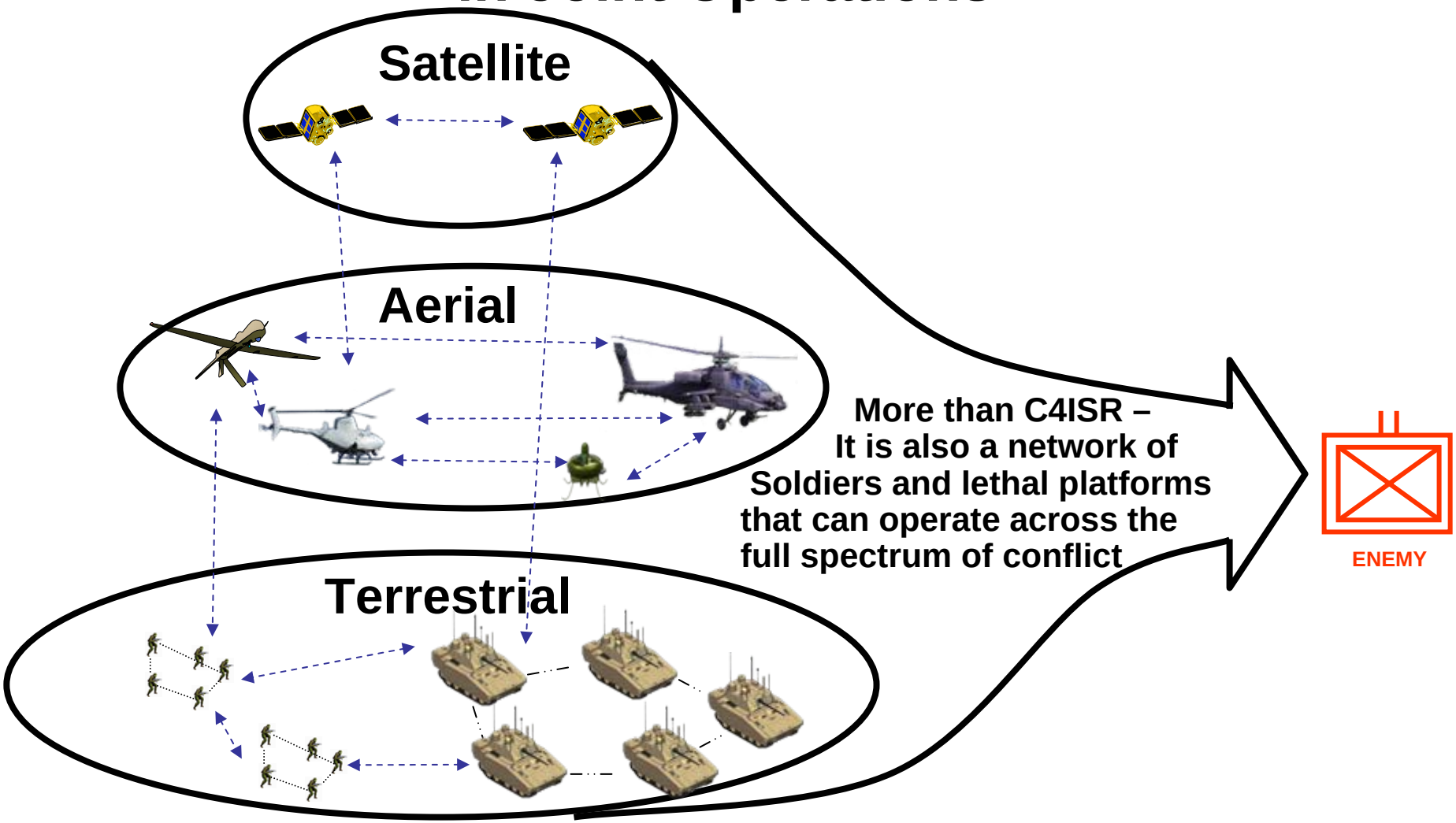
Armed Robotic Vehicle – Assault (Light) (ARV-A-L)

Mounted Combat System (MCS)



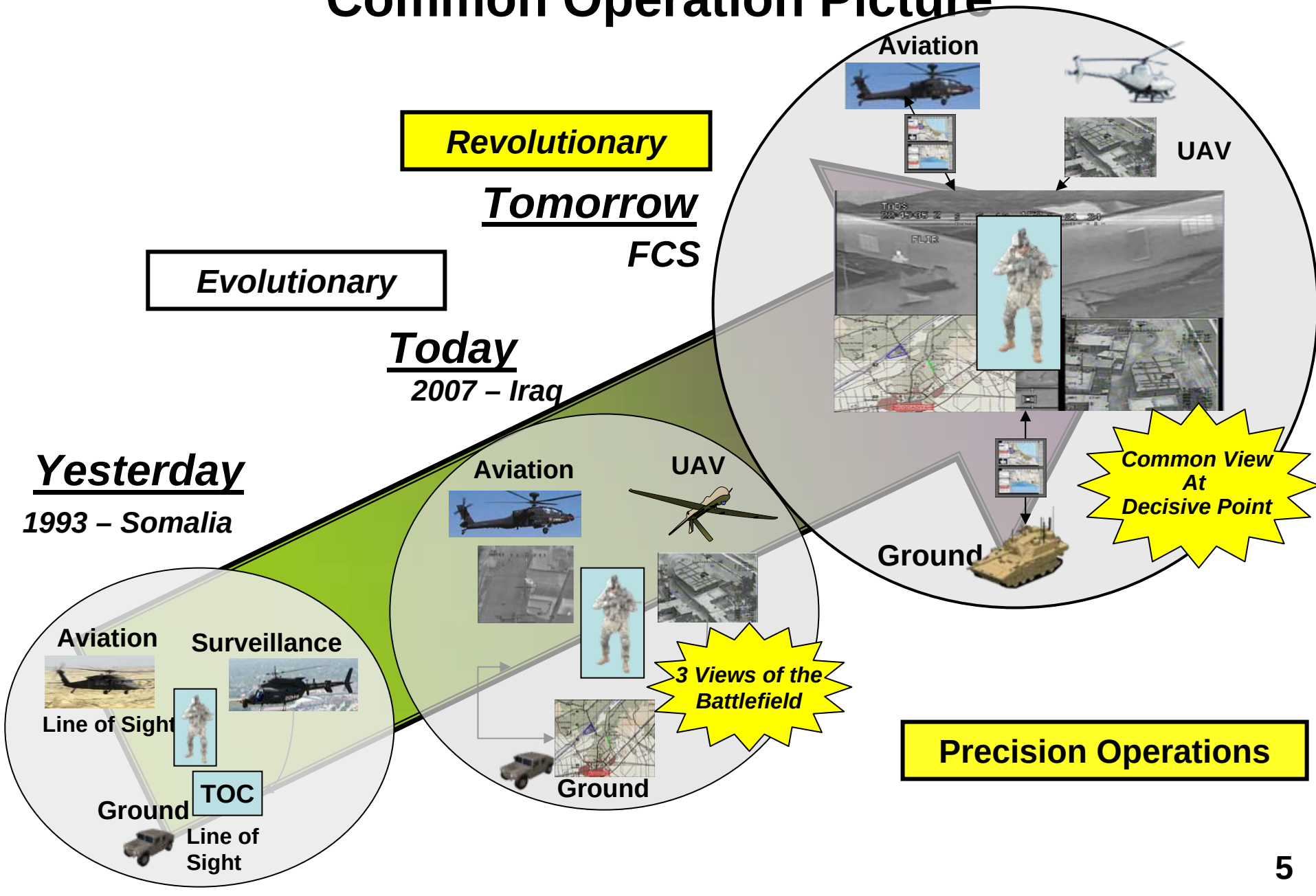
Infantry Carrier Vehicle (ICV)

Vision for Future Networked Land Forces in Joint Operations

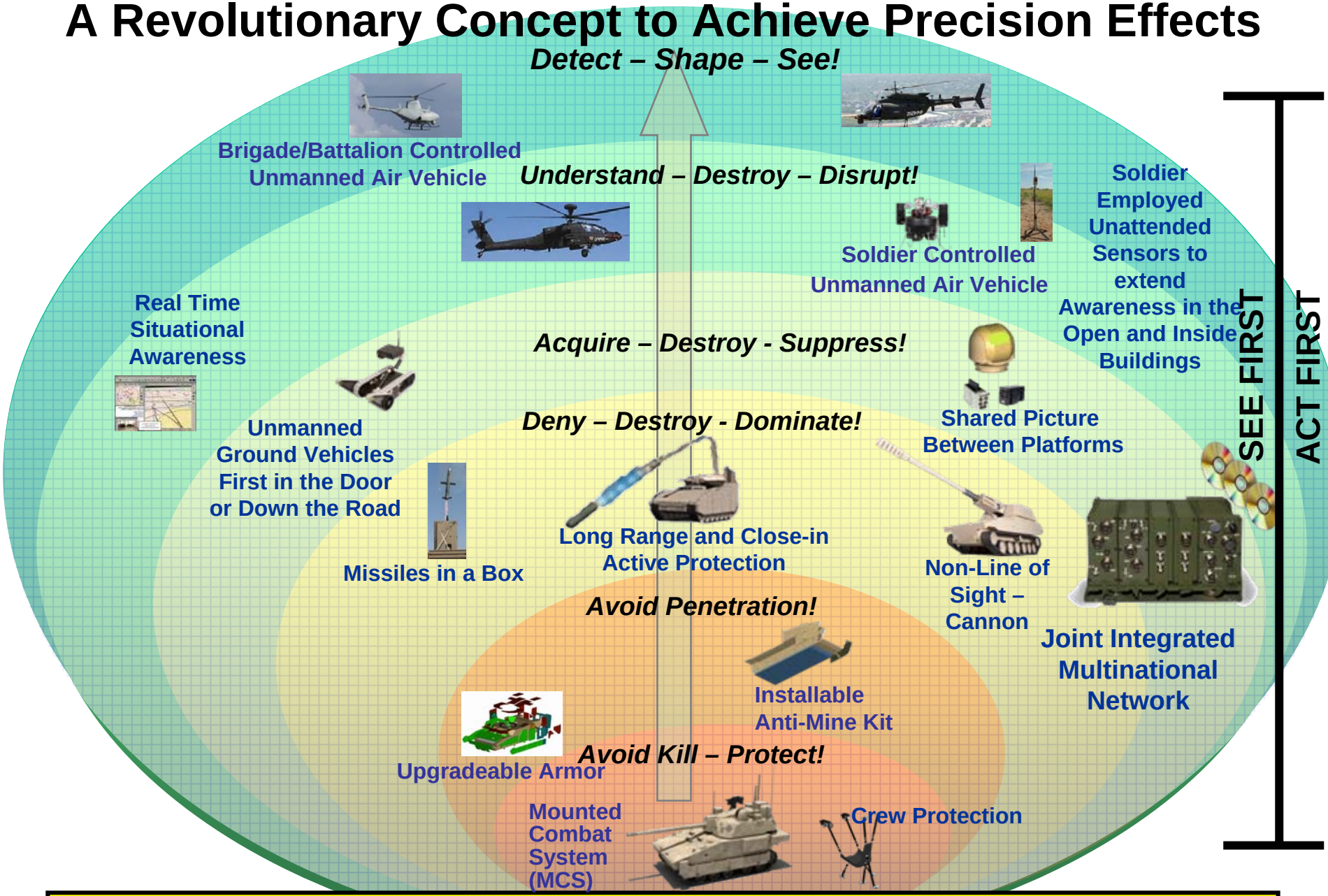


Redundant, Scalable, and Tailorable <u>On-the-Move Networks</u> enable Situational Understanding to Focus Effects with Precision

Capabilities in Action --- Future Common Operation Picture



A Revolutionary Concept to Achieve Precision Effects



Networked Soldiers Engage the Enemy at a Distance
And Close with the Enemy under Armor Protection Layer

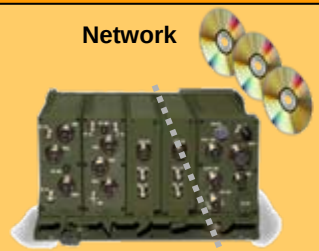
FCS Brigade Combat Team Platforms

Communicate / See / Understand / Act

Command and Control Vehicle (C2V)

Reconnaissance And Surveillance Vehicle (RSV)

Network



Class IV UAV

T-UGS

U-UGS

Tactical and Urban Unattended Ground Sensors

Class I UAV

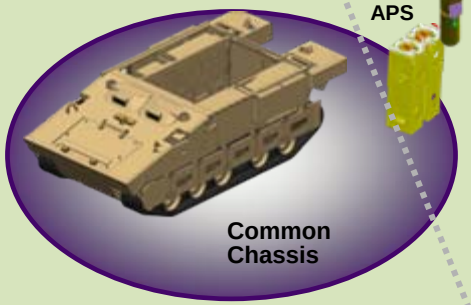
Spin-Outs

Move

Medical Vehicle Treatment (MV-T)

FCS Recovery and Maintenance Vehicle (FRMV)

Medical Vehicle Evacuation (MV-E)



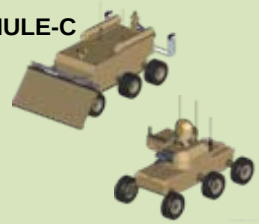
Common Chassis

APS

MULE-T

Multifunction Utility/ Logistics and Equipment Countermine and Transport

MULE-C

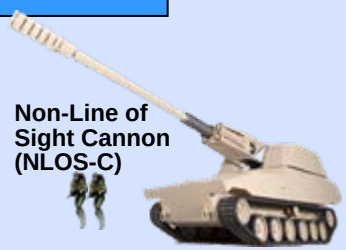


Armed Robotic Vehicle – Assault (Light) (ARV-A-L)

Small UGV (SUGV)

Shoot

Non-Line of Sight Cannon (NLOS-C)



Mounted Combat System (MCS)

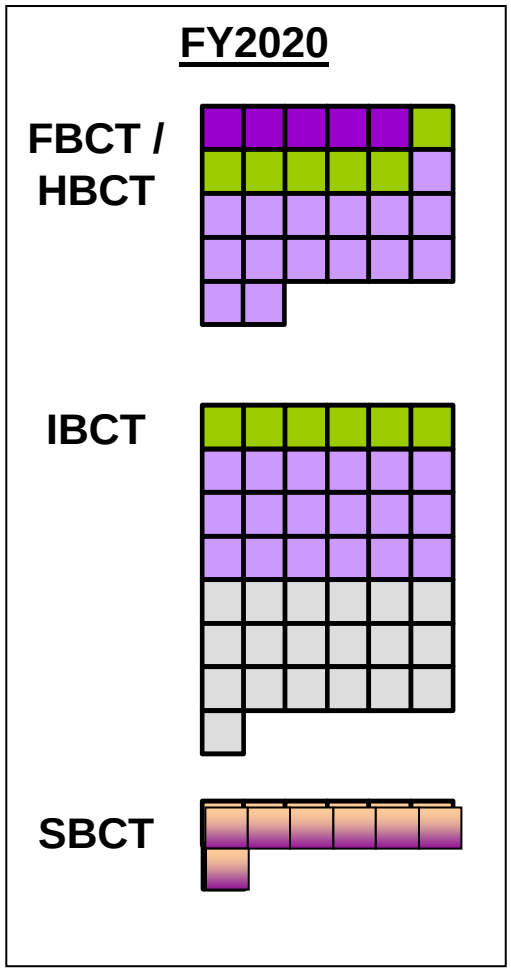
Infantry Carrier Vehicle (ICV)

Non-Line of Sight Mortar (NLOS-M)

Non-Line of Sight Launch System (NLOS-LS)

Greatly Enables and Protects the Soldier

Army Force Generation
With FCS Spin-out Capabilities in 2020



		RESET / TRAIN (recovery, reset, new equipment)	READY AVAILABLE (mission training, increased capability)	READY AVAILABLE (Deployed or ready for immediate deployments)	Increased Capability
FBCT		2	2	1	Exponential increase in situational awareness, lethality, survivability, supportability
HBCT	SO1	1	3	2	Significant increase in Situational Awareness, Battle Command on the move, persistent surveillance
	SO3	4	6	5	
IBCT	SO1	3	3	3	Significant increase in Situational Awareness, Battle Command on the move, persistent surveillance, forced entry precision fires
	SO3	9	3	3	
SBCT	SO2	2	3	2	Significant increase in Situational Awareness, survivability , Battle Command on the move, persistent surveillance
Total		21	20	16	

57 of 76 BCTs with FCS spin-outs / FBCT

- 5 FBCTs (five HBCTs converted to FBCTs)
- 21 of 21 HBCTs with FCS spin-outs
- 24 of 43 IBCTS with FCS spin-outs
- 7 of 7 SBCTs with FCS spin-outs

9 of 16 Available BCTs have FCS Network Capability

BACK UP

Army Direct Fire Capability Comparison

	Transportability and Weight	Lethality (Kill Capability)	Survivability
Abrams Tank 	**Aircraft** 1 per C-5 1 per C-17 **Weight** 70 Ton	• Dismounted Enemy / Bunkers • Defeats heavy armor with no autoloader • Only provides Line of Sight engagements	**Protection** • Passive Protection **Threat** • All Small Arms • Rocket Propelled grenades • Indirect Fires • Tanks • Most Explosively Formed Penetrators
Future Combat System Mounted Combat System 	**Aircraft** 3 per C-5 3 per C17 **Weight** 27 Ton Design	• Dismounted Enemy / Bunkers • Defeats heavy armor with autoloader = reduced crew • Provides Beyond Line of Sight Precision engagements	**Protection** • 360 Degree Active / Passive Protection • Networked Layered Protection Strategy **Threats** • All Small Arms • Rocket Propelled grenades • Indirect Fires • Tanks • Most Explosively Formed Penetrators
Stryker Mobile Gun System 	**Aircraft** 4 per C-5 3 per C-17 **Weight** 23 Ton	• Dismounted Enemy / Bunkers • Defeats light armor / bunkers w/autoloader = reduced crew • Only provides Line of Sight engagements	**Protection** •Passive Protection **Threat** • All Small Arms • Rocket Propelled grenades • Indirect Fires • Some Explosively Formed Penetrators

Brigade Combat Team (BCT) Operational Comparison

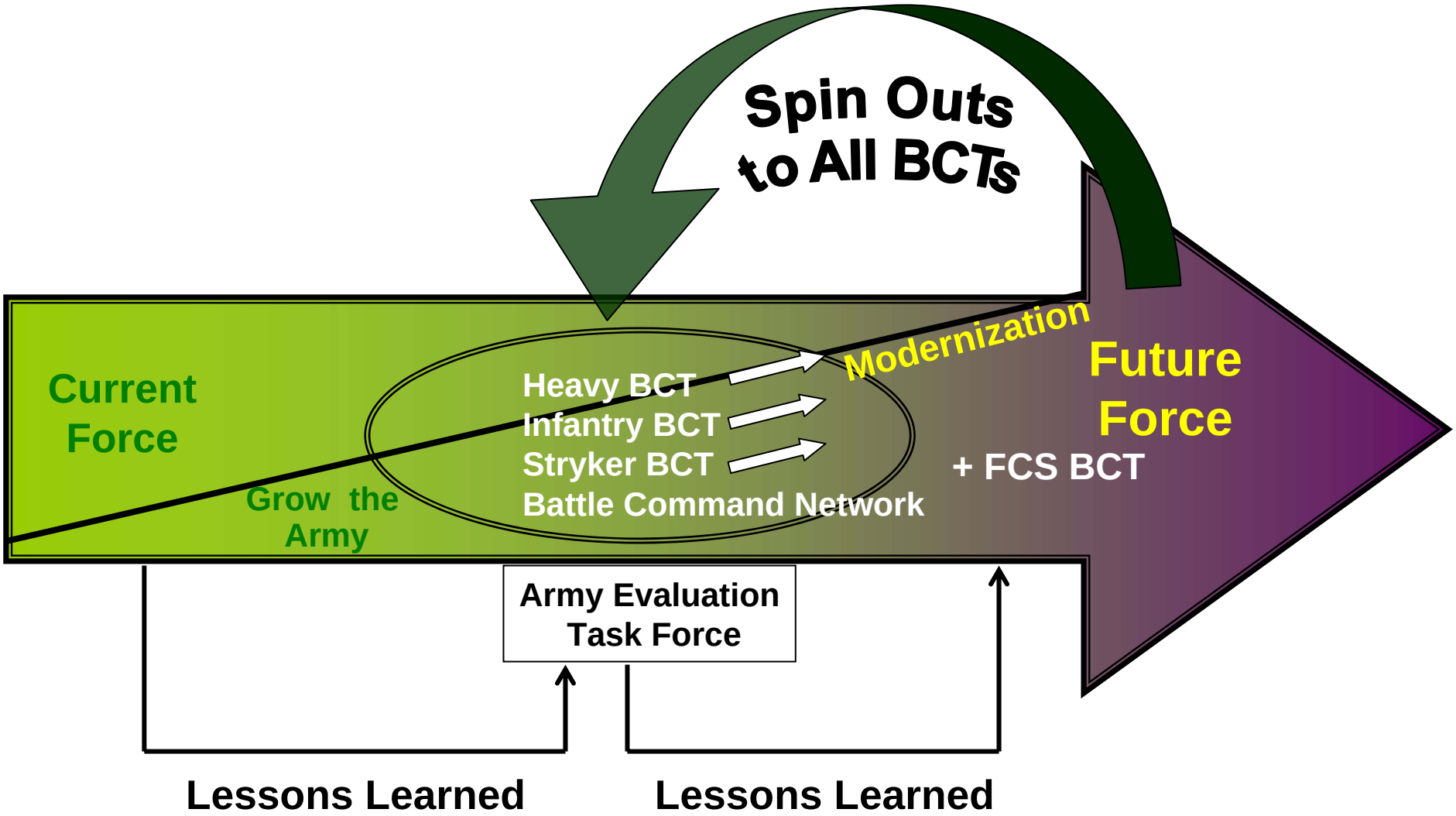
Comparison Criteria ↓ / Unit Type →	**Heavy BCT** with Abrams	**FCS BCT** with Mounted Combat System	**Stryker BCT** with Mobile Gun System
Capability Improvements			
Soldiers	3876	3219	4087 *
Self Sustaining (Hi OPTEMPO)	24 hours	72 hours	72 hours
Wartime Vehicle Availability	<90%	>95%	>90%
Infantryman in Squads	324 (8% of HBCT)	702 (22% of FCS BCT)	918 (23% of SBCT)
Support Soldiers (Based off Brigade Support Battalions)	1186 (31% of HBCT)	411 (13% of FCS BCT)	724 (18% of SBCT) includes 103 CLS civilians
Average maintenance man hours per operating hour	1:2	1:20	1:10
Revolutionary Improvements			
Maintenance tasks performed by crew chief	10%	80%	10% (with CLS)
Platform health status	Only vehicle crew understands	Visible thru networked logistics to entire BCT	Only vehicle crew understands
Power	Motors and generator (power consumer)	Hybrid electric (power generator)	Motors and generator (power consumer)
Training	Stand alone simulators (select locations)	Embedded training (anywhere)	Stand alone simulators (select locations)

* Note: (Plus 103 Contractor Logistics Support (CLS))

Current vs Future Combat Teams

	Heavy Modular BCT	FCS BCT
Capability Improvements		
Self Sustaining (Hi OPTEMPO)	24 hours	72 Hours
Wartime Vehicle Availability	<90%	>95%
Infantrymen in Squads	324 (8% of HBCT)	702 (22% of FCS BCT)
Support Soldiers	1186 (31% of HBCT)	411 (13% of FCS BCT)
Average maintenance man hours per operating hour	1 to 2	1 to 20
Revolutionary Improvements		
Maintenance tasks performed by crew chief	10%	80%
Platform Health Status	Only vehicle crew understands	Visible to entire Brigade through networked logistics
Power	Motors and generators (Power Consumer)	Hybrid Electric (Power Generator)
Training	Stand alone Simulators (in select locations)	Embedded Training (Anywhere)

Here's Where We are Going



Current and Future Force Enabled

Automatic Targeting Solutions Over Heterogeneous Databases Using Intelligent Agents

Presenter: Keith Davis
Integrity Applications Incorporated

Danny Searle & Nathan Kielman
NAVAIR Weapons Engagement Office

Ken Abeloe & Dan Crisp
Integrity Applications Incorporated

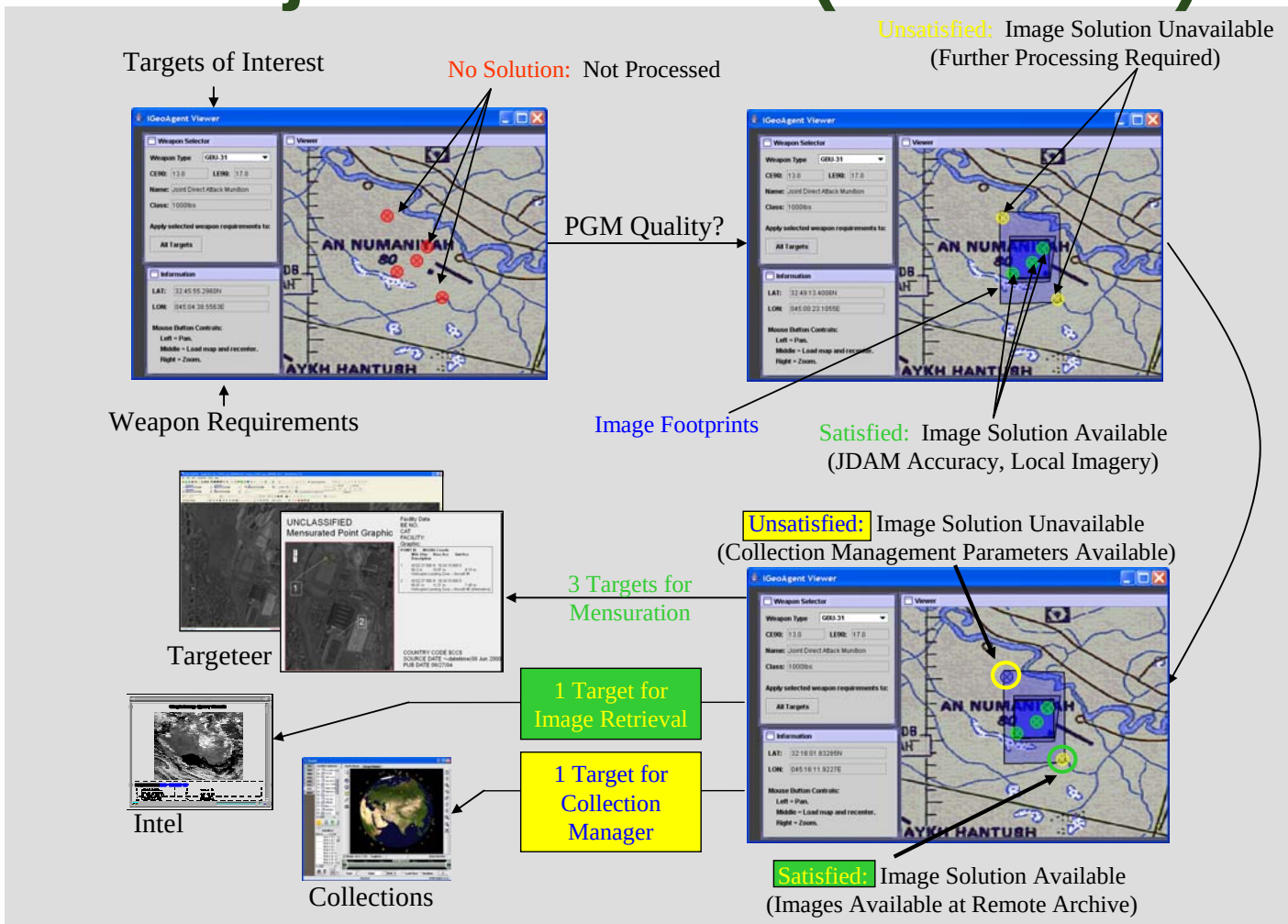
iGeoAgent

Project Overview

Operational Statement: Streamlines time critical targeting (TCT) processes by providing real-time updated precision IMINT solutions to targeteers, weaponeers, mission planners, and intel analysts.

iGeoAgent

Project Overview (CONOPS)

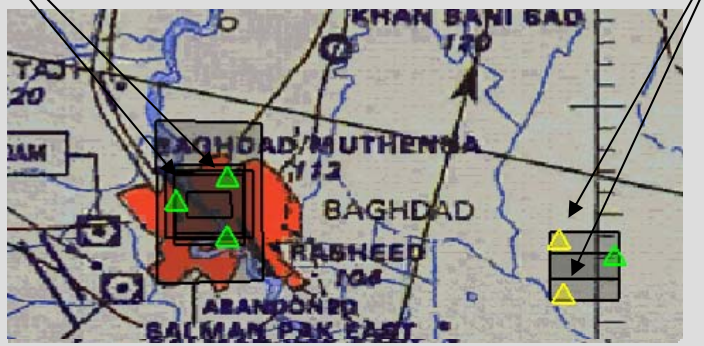


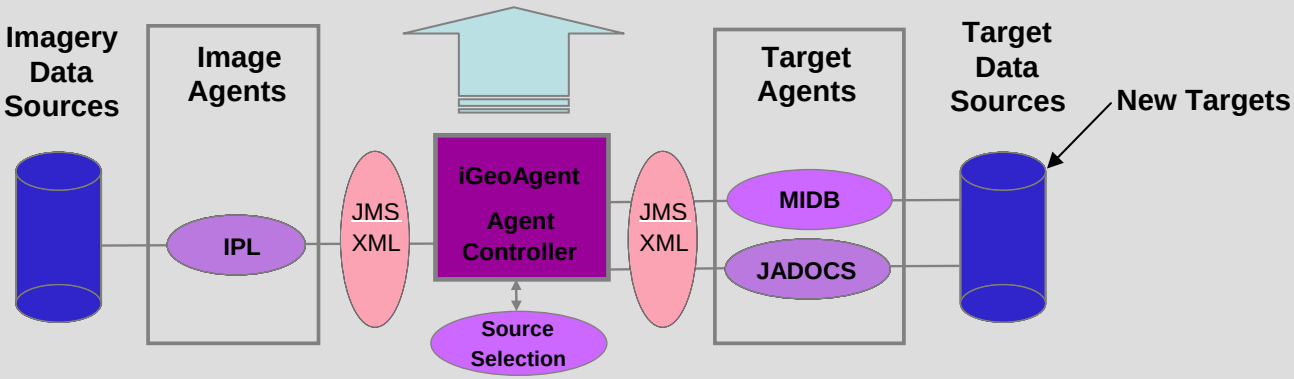
iGeoAgent

Project Overview (First Phase)

Satisfied Targets
(Ready to Strike)

Unsatisfied Targets
(Further Processing)





Back

Next

iGeoAgent

Precision Solution Determination

- Various individual images are combined and tested using rigorous sensor models
  - Only image header data is required
  - 1- 5 images combinations are tested
- Solutions are determined for various PGM's
  - SDB, JDAM, JSOW, SLAM-ER
- Solutions are determined for NTM, DPPDB, Commercial products

iGeoAgent

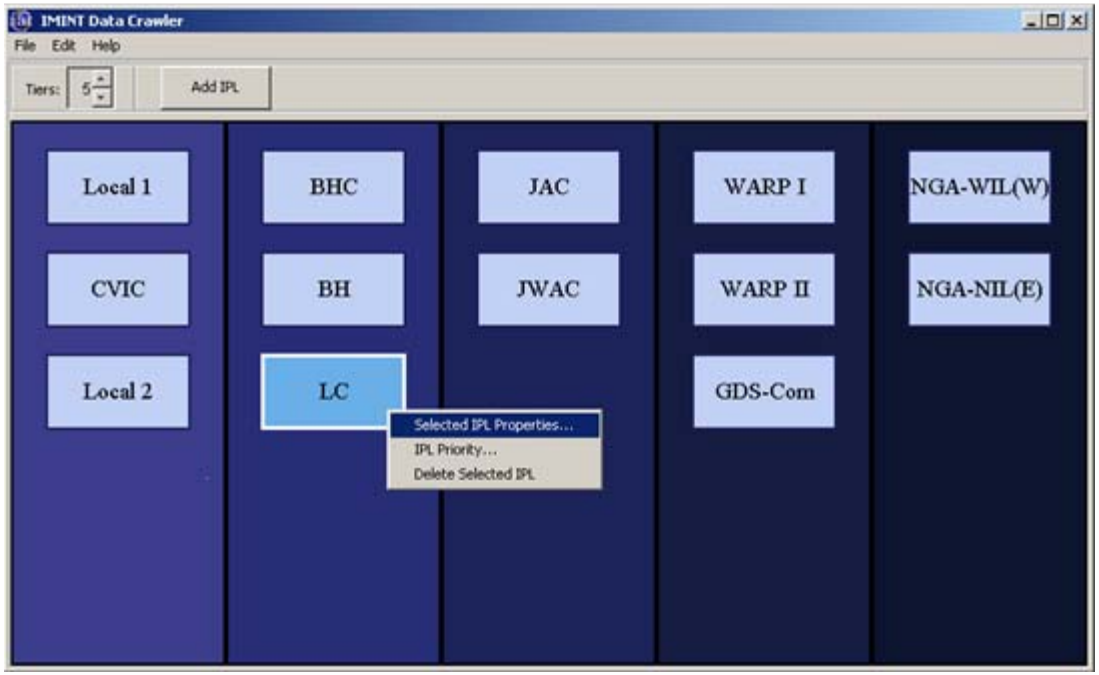
Precision Solution Determination

- Individual images are weighted based on external information
  - Support Data: NIIRS, GSD, Elevation Angle
  - Time of Collection
  - Weather Conditions (per user specification)
- Higher FOM images are prioritized in the source selection algorithm

iGeoAgent

Further Processing (IMINT Data Crawler)

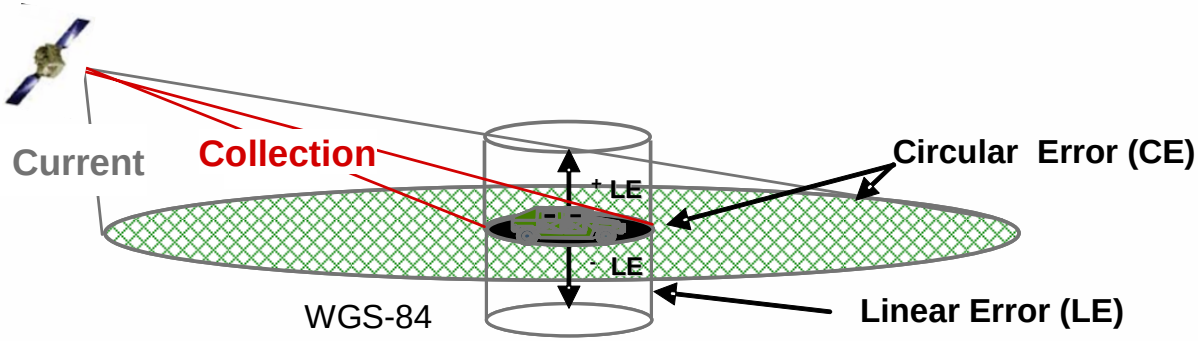
- IMINT archives are crawled (query, retrieve) using a tiered approach for potential coverage
  - FOM's are applied to weigh dissemination time and ease of access



iGeoAgent

Further Processing (Collections)

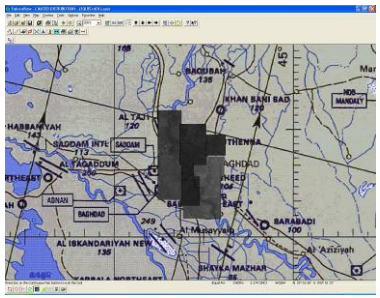
- No IMINT solutions are available to meet a PGM accuracy requirement
- Messaging triggers a reverse source selection request
  - Inputs: Accuracy requirement, Failed Images
  - Outputs: Sensor tasking parameters for acquiring an additional 1-2 NTM image to meet accuracy



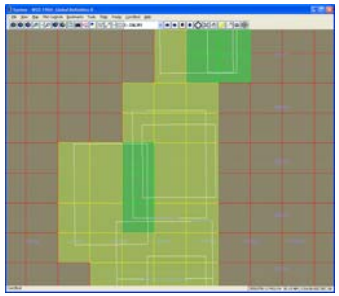
iGeoAgent

Further Processing (Feedback)

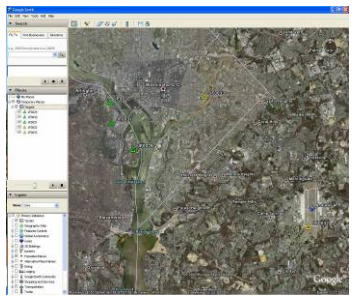
- Solutions set can be rejected by 3rd party apps through a web service interface
- Output results are available through web service
  - Visualization Systems: FalconView, Google Earth, GCCS COP
  - FIRES Systems: JADOCS



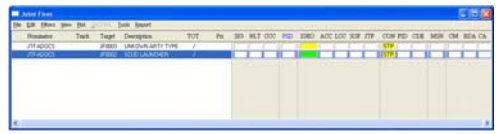
FalconView



GCCS COP



Google Earth



JADOCS

Back

Next

iGeoAgent

Conclusions

- Provides weaponeers, targeteers, and mission planners insight into the current availability of IMINT precision solutions
- Eliminates the manual hunt and peck process for locating data in time critical situations
- Increases the utilization of NTM and Commercial products (alternative to potentially old DPPDB)

ONR

Revolutionary Research . . . Relevant Results

Office of Naval Research

S&T Strategy for Power Projection

Mr. Michael Deitchman, SES

Deputy Chief of Naval Research

Naval Air Warfare and Weapons (Code 35)

23 October 2007

DoN S&T Corporate Board Approval

Revolutionary Research . . . Relevant Results

DEPARTMENT OF THE NAVY
ASSISTANT SECRETARY OF THE NAVY
RESEARCH, DEVELOPMENT AND ACQUISITION (20350-1000)
OFFICE OF THE VICE CHIEF OF NAVAL OPERATIONS (20350-2000)
HEADQUARTERS UNITED STATES MARINE CORPS (20350-3000)
WASHINGTON, DC

JAN 19 2007

MEMORANDUM FOR THE CHIEF OF NAVAL RESEARCH

Subj: SCIENCE AND TECHNOLOGY CORPORATE BOARD DECISION MEMORANDUM

1. The Corporate Board endorses and approves the Naval Science and Technology Strategy presented at the 12 December 2006 Science and Technology Corporate Board meeting and directs the Chief of Naval Research to implement the strategy.

R. Magnus	R. F. Willard	Dr. Delores M. Etter
General, U. S. Marine Corps	Admiral, U.S. Navy	Assistant Secretary of the Navy
Assistant Commandant of	Vice Chief of Naval Operations	Research, Development and
the Marine Corps		Acquisition

DoN S&T Strategy Objectives

- **Ensure alignment of Naval S&T with Naval missions and future capability needs**
- **Communicate S&T vision and approach to senior decision makers, key stakeholders, S&T partners, customers and performers**
- **Balance and manage S&T portfolio based on key tenets:**
  - **Strive to touch intellectual capital worldwide**
  - **Leverage U.S. and global technology insights**
  - **Sponsor primarily external performers**
  - **Maintain NRL in-house research capability as the Navy/Marine Corps Corporate Laboratory**
  - **Manage a balanced portfolio with technical Program Officers**

Naval Warfighting and Support Functions

Revolutionary Research . . . Relevant Results

Naval S&T Focus Area	Naval Warfighting and Support Functions
Power & Energy	• Power Generation and Storage • Assured energy sources• Man Portable & Lightweight • High-Density Power
Operational Environments	• Oceanography & Survey (Ocean/Hydro/River) • Meteorology • Space Environmental Effects
Maritime Domain Awareness	• ISR collection & integration • CBRNE (Explosives & WMD Detection) • Port/Base Security • Swimmer Detection • Wide Area & Battlespace Surveillance • Social/Cultural Understanding • MIO Sensing • HLS Ship Tracking
Asymmetric & Irregular Warfare	• Operational Adaptation • Maritime/Riverine Interception Operations • Expeditionary Security • Boat/Vehicle Disabling (Apply Non-Lethal Systems & Effects) • Forensic Site Exploration • Tactical Evidence Collection • Counter IED/Snipers • Riverine Operations • Regional Domain Awareness • Homogeneous Cultural Integration of Forces • Tactical Tagging and Tracking
Information, Analysis and Communication	• Assured and Secure Communications • Electronic Warfare • Computer Network Ops • Operations Security • Military Deception • Cross Cultural Communications • Threat Intent Determination • C4
Power Projection	• **Rapid Tactical Precision Targeting • Time-sensitive strike • Neutralization (lethal/non-lethal) • Effects-scaled weapons • Integration & Control of Naval fires • Maneuver**
Assure Access and Hold at Risk	• Persistent Surveillance & Monitoring • Tagging/Tracking & Locating • Shaping and Information Operations • Strategic Target ID/Tracking • Information Verification • Vessel/vehicle-stopping • MIO/Boarding • ASW & MCM • Spoof/Decoy
Distributed Operations	• Distributed Logistics • Small Unit ISR/Intel Collection/Dissemination/Fusion & Engagement • Tactical Maneuver & Mobility • Control of Integrated Fires • Training Operations in Urban/Extreme Environments • Large target lethality with reduced combat loads • Control Collateral Damage
Naval Warrior Performance and Protection	• Personal Protection • Endurance • Decision-Making Tools • Decision/Training Tools • Casualty Prevention/Care • Undersea Medicine • Enhanced Human Performance • Operating in Extreme/Austere Environments • Expeditionary Security • Training Operations in Urban Environments
Survivability and Self-Defense	• Missile Defense • Torpedo Defense • LO/CLO • Tactical EW • Damage Control/Prevention • Force Protection • Time-Critical Terminal Defense
Platform Mobility	• Platform Performance & Agility • Power-Dense Propulsion • Operational Adaptation • Tactical Maneuver Mobility
Fleet/Force Sustainment	• Seabasing • Operational Logistics • Maneuver
Affordability, Maintainability, and Reliability	• Increased warfighting capacity• Reduced logistics cost optimization reduced failure rates • Automate Naval engineering • Aircraft Propulsion Design • Reduce Manning • M&S Automation • Reduce Upgrade Costs

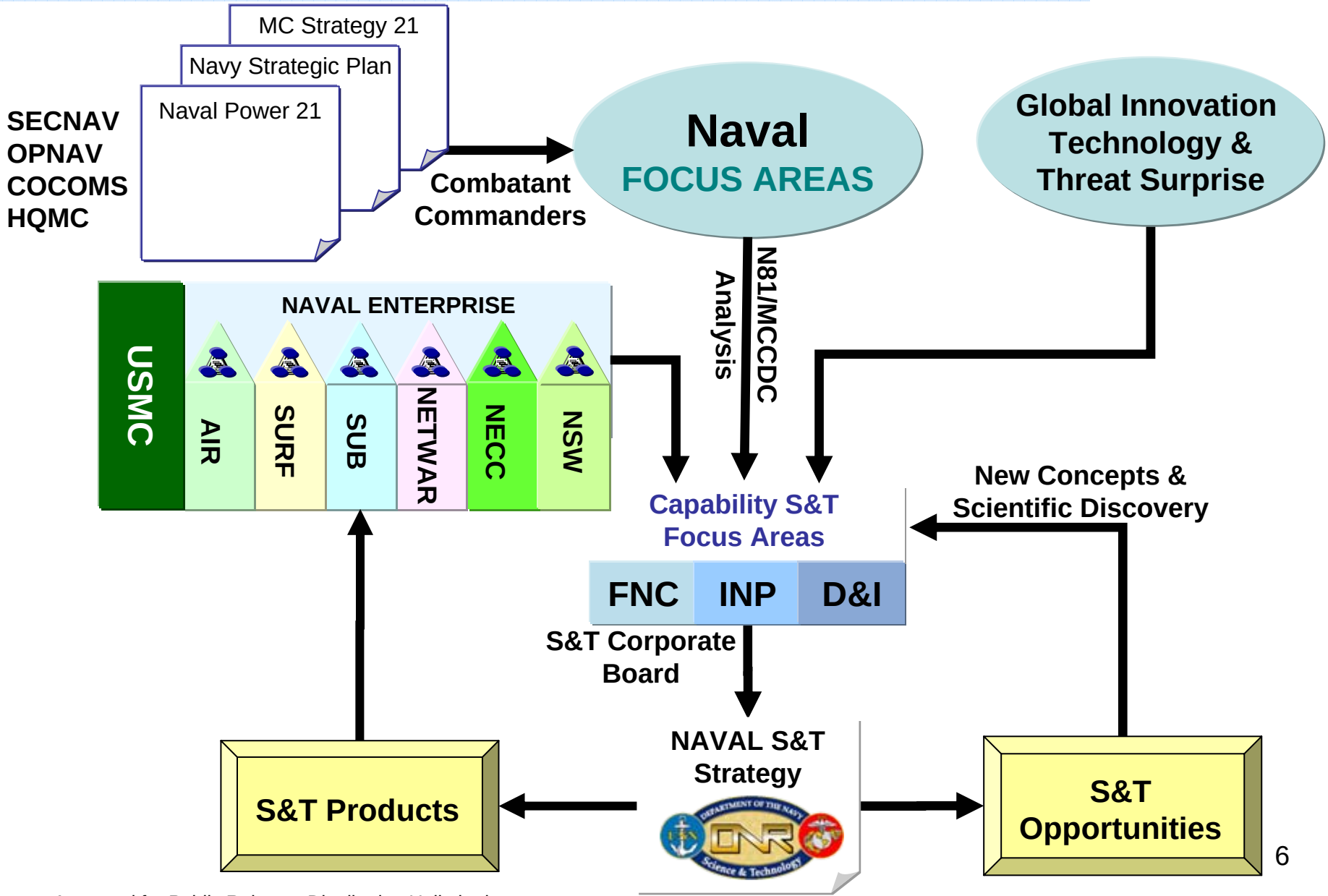
Results of S&T Strategy

Revolutionary Research . . . Relevant Results

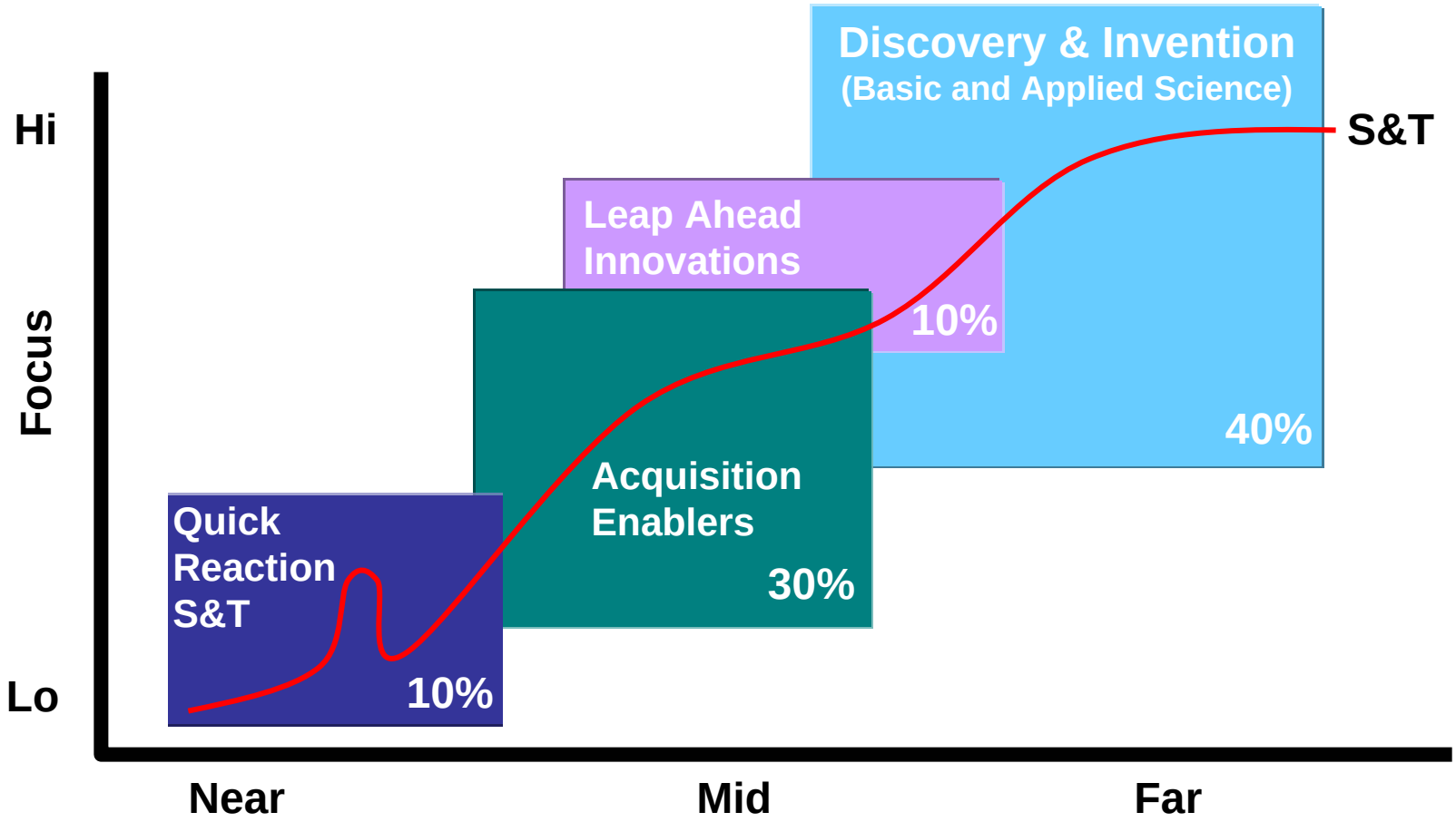
Navy and Marine Corps will have:

- Domination of the Electro-Magnetic spectrum and cyber space
- Implemented Directed Energy – Fighting at the Speed of Light
- Achieved persistent, distributed surveillance in all domains
- Achieved comprehensive MDA with large vessel stopping and WMD detection for EMIO
- Incorporated affordability into platform design and construction
- Adaptive, wireless communications networks
- Decision tools for Commanders that provide tactical advantage
- Determination of threat intent thru social / cultural understanding
- Lighter, faster, more lethal Marine forces
- Accelerated team training & skill development
- Increased operational effectiveness thru more efficient power/fuels
- Responsive / visible logistics to enable distributed forces
- Greater tactical advantage through superior knowledge / use of operational environments

Naval S&T Strategy Process



DoN S&T Portfolio Balance



S&T has a long-term focus but is responsive to near - term Naval needs

Types of ONR programs

Revolutionary Research . . . Relevant Results

	Discovery and Invention	Future Naval Capability	Direct Fleet Support / Quick Reaction	Innovative Naval Prototype
% of Portfolio	**40**	**30**	**10**	**10**
Focus	**Expanding frontiers of knowledge in areas of naval interest**	**Transitioning mature S&T to acquisition program of record**	**Solving emergent fleet / force needs**	**Demonstrating Leap-ahead technology**
Motivation	**Broad Naval needs and opportunities**	**OPNAV-identified capability gap**	**Fleet-identified need**	**Significant military advantage**
Example	**Ocean Acoustics**	**Improved water jet propulsion for JHSV**	**IED Jammer**	**Electromagnetic Railgun**
Type of Innovation	**Disruptive or sustaining.**	**Sustaining - makes an existing capability better**	**Disruptive or sustaining.**	**Disruptive - makes an existing capability obsolete**
Time frame	**continuing**	**3-5 years**	**1-2 years**	**4-8 years**
Typical TRL entry point	**TRL-0 to TRL 2**	**TRL-3**	**TRL-4 to TRL-5**	**TRL-2 to TRL-3**
Typical TRL end point	**TRL-3 to TRL-4**	**TRL-6**	**TRL-7**	**TRL-6**
Technical Difficulty	**High**	**Medium**	**Medium**	**High**
Operational Integration Complexity	**N/A**	**Usually straightforward**	**Medium**	**High**
Approval Level to start a program	**ONR Department**	**Technology Oversight Group (3-Star)**	**ONR Corporate**	**DON Corporate Board (4-Star)**

Power Projection

Revolutionary Research . . . Relevant Results

Vision: Precise extended range indirect fires, time-critical power on target and control of collateral damage through electromagnetic kinetic projectiles, hypersonic missile propulsion and scalable effects weapons.

Objectives

Future Navy Fires
- Increased fires volume & accuracy
- GPS denial compensation
- Indirect fires to 250 miles from safe offshore locations

Control Collateral Damage
- Scalable effects weapons
- Selectable/directional lethality

Time Critical Strike
- Hardened target/moving target reach & destroy
- Worldwide to meet warfighter requirements

Small Unit Combat Power
- Increased small unit weapon lethality
- Neutralize larger hostile forces

Combat Insensitive Munitions:
- Reduce system sensitivity to sympathetic detonation
- Maintain payload range & lethality

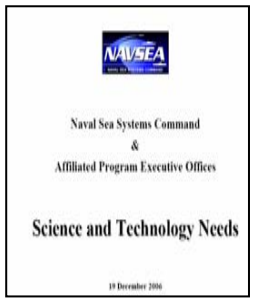
Key Research Topics

Advanced Energetics
Directed Energy
Electromagnetic Guns
High Speed Weapons Technologies
Precision Strike
Undersea Weaponry
ASW Rapid Attack
Mining
Non-Lethal Weapons
Signature Control & Sensors (LO/CLO)
EW Attack
Expeditionary Firepower

Power Projection S&T Needs

Revolutionary Research . . . Relevant Results

Power Projection Needs



Naval Sea Systems Command & Affiliated PEOs

- Science and Technology Needs 19 December 2006
- Surface Community POM08 Investment Guidance

NETWARCOM

- Top 10 Fleet Requirements Sep 2006
- PEO C4I Science and Technology Alignment and Transition CONOPS

  29 Sep 2006

Marine Corps

Science and Technology Strategic Plan
August 2007

Undersea Enterprise (USE)

SCIENCE AND TECHNOLOGY (S&T) PRIORITY TECHNICAL CHALLENGE AREAS OF INTEREST
07 APR 2006

Naval Aviation Enterprise

Science and Technology Strategic Plan
Commander Naval Air Forces
Commanders Naval Air Systems Command
Director, Air Warfare
01 July 2006

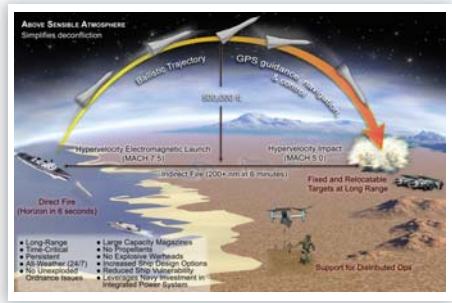
Navy Expeditionary Combat Command

Science and Technology Objectives (STOs)
DRAFT as of 05 June 2007

- **N8F FNC Gaps (PR 09, POM 10)**
- **Communication with N8F, N81, N85, N86, N87, N88 Science Advisors**

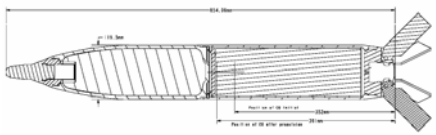
Future Naval Fires

Advanced Gun Barrel



EM Railgun

HyFly



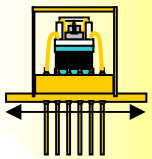
Enhanced Lethality & Range Munition

Increased Fires Volume and Accuracy

Indirect Fires to 250 miles from Safe Offshore Locations

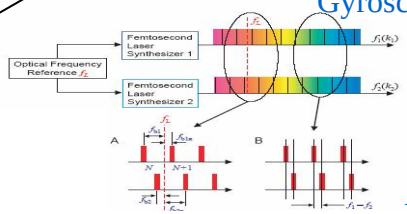
RATTLRS

GPS Denial Compensation



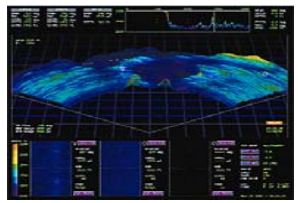
Tactical Grade Gyroscope/Accelerometer

Celestial Navigation System



Optical Frequency Standards

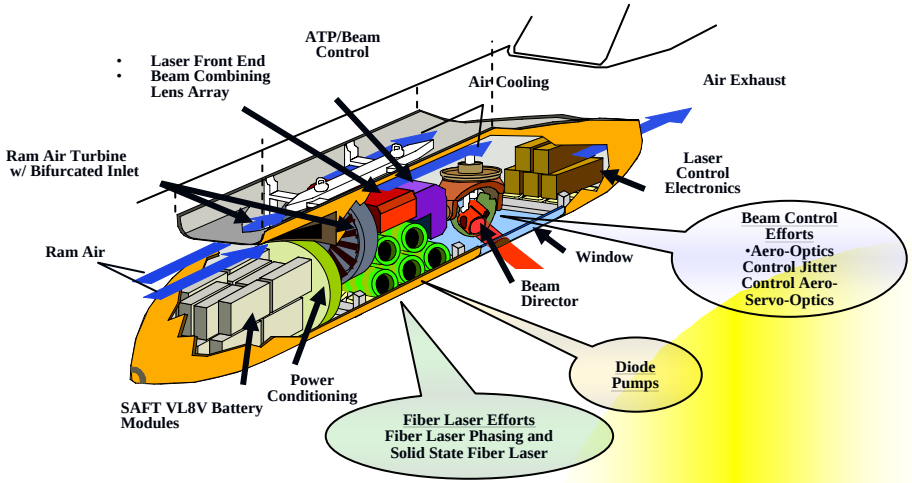
Anti-Jam/Anti-Spoofer System



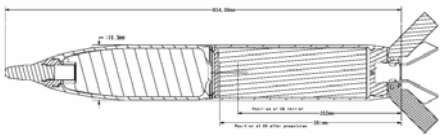
Adaptive Bathymetric Estimator (ABE)

Tactical COTS Rb Atomic Clock

Control Collateral Damage



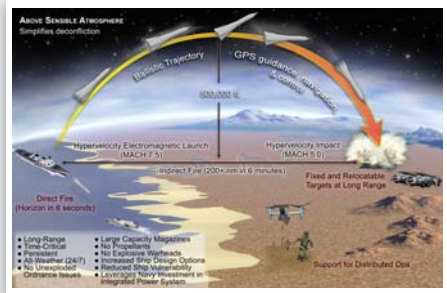
HEL for Tactical Air Applications



Enhanced Lethality & Range Munition

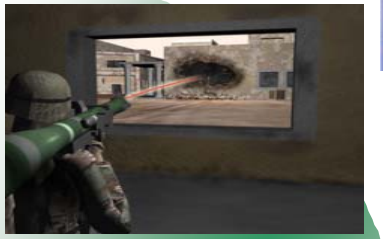
Next Generation Airborne Electronic Attack (AEA) Enabling Capability

Selectable/ Directional Lethality



EM Railgun

MEMS Fuze



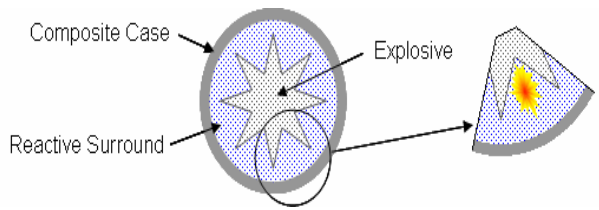
Future Assault Weapon Munition

Scalable Effects Weapons

Modular Scalable Effects Weapon

Advanced Energetic Materials

Future Mortar Munition



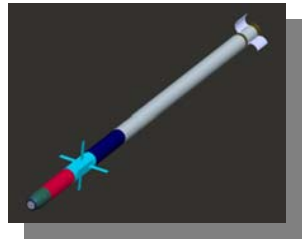
Enhanced Blast/ Scalable Effects Bomb

Time Critical Strike

RATTLRS

Combustion Light Gas Gun

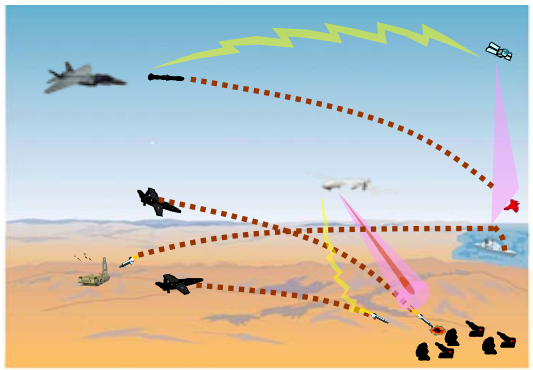
HyFly



Low Cost Imaging Terminal Seeker

Free Electron Laser

Weapon Data Link



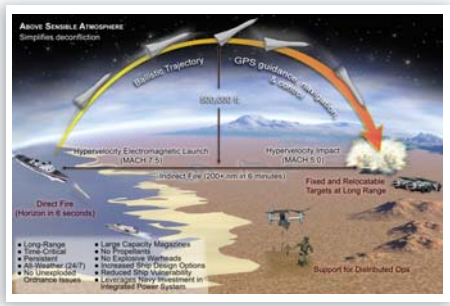
Enhanced Weapons Technologies

Worldwide to meet Warfighter Requirements

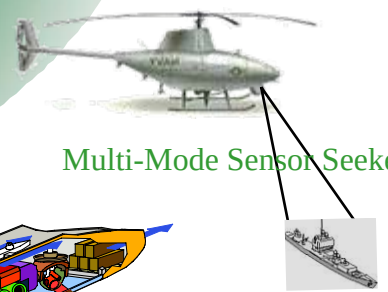
Hardened Target/ Moving Target Reach & Destroy

Direct Attack Seeker Head

M-VIVID

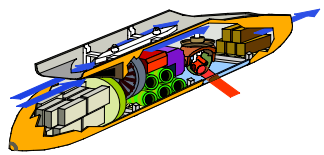


EM Railgun



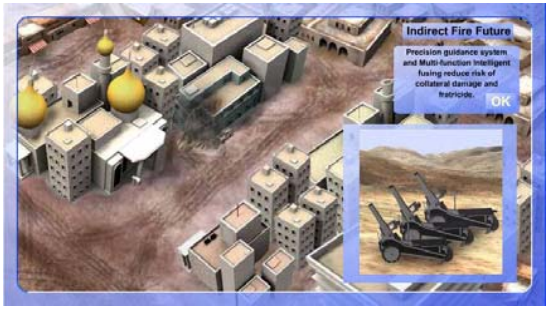
Multi-Mode Sensor Seeker

Advanced Propulsion Concepts (Pulse Detonation Engine shown)



HEL for Tactical Air Applications

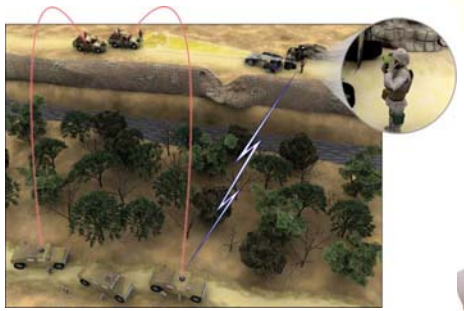
Small Unit Combat Power



Modular Scalable Effects Weapons

Enhanced Lethality & Range Munition

Future Assault Weapon Munition



DO Precision Engagement

Advanced Energetics Materials

Neutralize Larger Hostile Forces

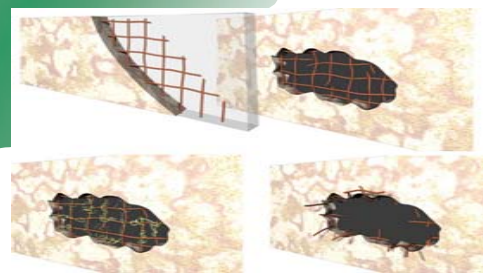
Increased Small Unit Weapon Lethality

MEMS Fuze

Energetics D&I

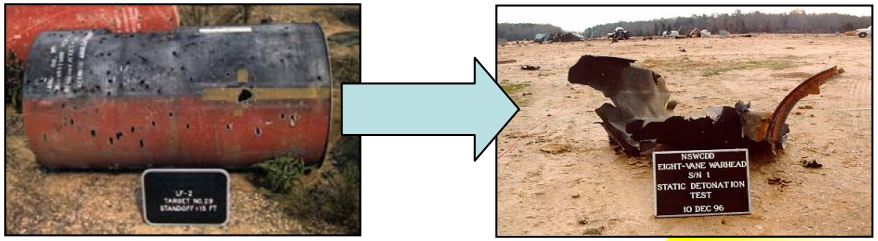
Future Mortar Munition

Assault Weapon Propulsion

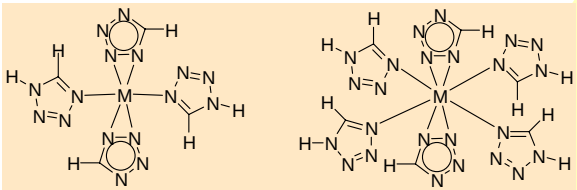


Tactical Urban Breaching Munition

Combat Insensitive Munitions

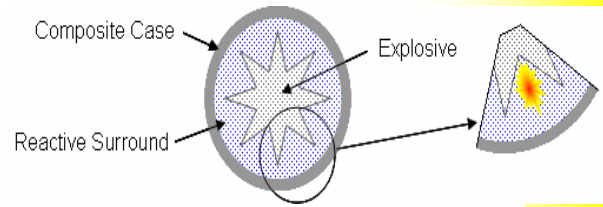


Reactive Materials



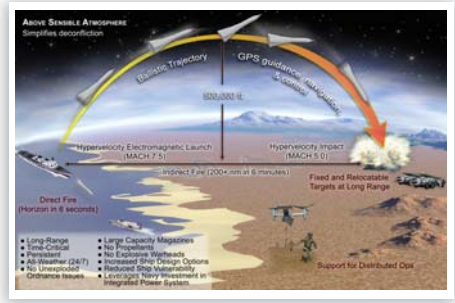
Emerging Energetic Materials

Maintain Payload Range and Lethality

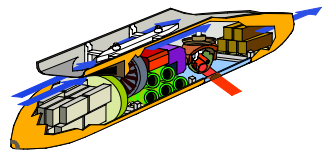


Enhanced Blast/ Scalable Effects Bomb

Advanced Energetics Materials



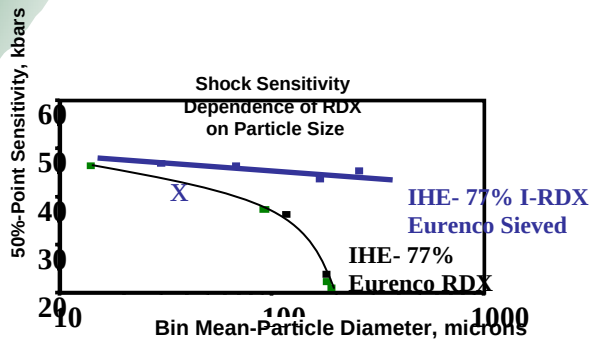
EM Railgun



HEL for Tactical Air Applications

Reduce System Sensitivity to Sympathetic Detonations

Free Electron Laser



CSIM Sensitivity

Naval Precision Strike Futures

Future Options

Tomahawk

Harpoon

Today's Cruise Missiles

1.0 3.0 5.0 7.0 Speed of Light

MACH

Testing Technology and C2 Structure Develops Tactical Tomahawk's Quick Reaction Precision Strike Capability (U)

Brief to PSTS
23 Oct 2007 (U)

Bill Druce
JHU/APL
443-778-1432
Bill.Druce@jhuapl.edu

LCDR Sean Gillespie
COMSECONDFLT TLAM
757-453-9850
gillespies@secondflt.navy.mil

The Johns Hopkins University
APPLIED PHYSICS LABORATORY

Objective

- **Describe how the Sea Trial program has been used to develop and validate Tactical Tomahawk capabilities to be used in the development of Joint Tactics Techniques and Procedures (JTTPs)**

Tomahawk Myths: "We don't task TLAM because . . .

- It's too hard to communicate with the firing unit."
- Tomahawk isn't responsive enough for a TST."
- Tomahawk can't provide any BDA."
- Tomahawk can't be recalled or redirected to a higher priority target."

FALSE

PROBLEM and SOLUTION

PROBLEM

- **How to develop, validate and demonstrate JTTPs (Joint Tactics Techniques and Procedures) that take full advantage of new capabilities?**

SOLUTION

- **Use Sea Trial process**
  - **Greyhound Express Exercise Series**
  - **JHAWK Quick Reaction Test**
  - **Joint Experimentation**
    - **Urban Resolve 2015**
    - **Joint Expeditionary Force Experiment (JEFX) 08**
  - **Operational Test Launches**

Greyhound Express

- Established at COMSECONDFLT
- Experimentation with TLAM C2 to shorten the kill chain
- 3rd Party Targeting using SOF to fix targets
- Led to COMSECONDFLT publishing 3PT TACMEMO

JHAWK QRT

- USSOCOM-sponsored quick reaction test
- One-year charter to develop and publish MTTP for 3PT of Tomahawk
- Used C2F TACMEMO as starting point
- Developing and validating TTP for immediate employment at joint operational level
- Publish MTTP May 2008

Joint Experimentation

- **Urban Resolve**
  - **Simulation of joint campaign in year 2015**
  - **COMSECONDFLT demonstrated fielded Block IV TLAM capability**
  - **Demonstrated dynamic targeting at joint operational level**
    - **JSOTF providing 3PT**
    - **JFACC clearing airspace**
    - **JFMCC retargeting missiles in flight**

- **JEFX 08**
  - **Time-sensitive planning in support of USSTRATCOM Global Effects Integration**
  - **Again demonstrating fielded Block IV TLAM capability**

Operational Test Launches

- Validate technology and JTTPs using Operational Test Launches
  - Operational SOF equipment and procedures
    - Field Targeting Devices
    - 9 line message
  - Tactical Tomahawk Capabilities
    - Launch Platform Mission Planning (LPMP)
    - Missile loiter
    - Redirection in flight
  - 3 Test Launches from December 2005 to September 2006
    - OTL 309
    - OTL 437
    - OTL 454 (JFCOM sponsored)

OTL 309 Objective

- **Objective is to demonstrate the ability of Tomahawk to engage a target using coordinates provided by Special Operations Forces (SOF)**

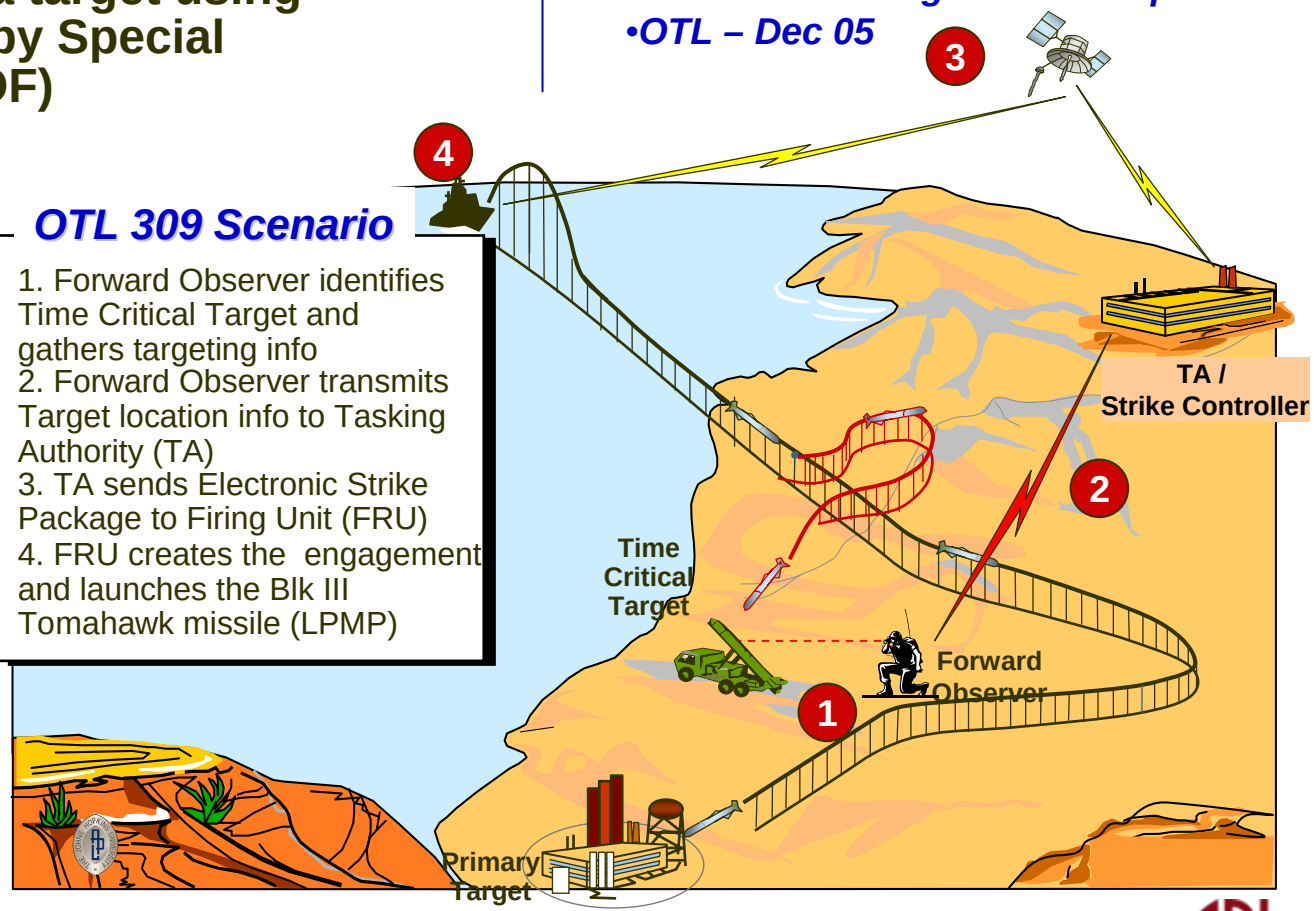
- *OTL-309 successfully conducted on 7 Dec 2005 at China Lake*

OTL 309 Project Events

- *Targeting Phase – Aug 05*
- *Mission Planning Phase – Sep 05*
- *OTL – Dec 05*

OTL 309 Scenario

1. Forward Observer identifies Time Critical Target and gathers targeting info
2. Forward Observer transmits Target location info to Tasking Authority (TA)
3. TA sends Electronic Strike Package to Firing Unit (FRU)
4. FRU creates the engagement and launches the Blk III Tomahawk missile (LPMP)



Evaluation of OTL-309 Objectives

- **Suitability**
  - **In this test, the TLE was small enough to fit within the GPS-only TPS error allocation**
  - **Not as accurate as the TPS is able to demonstrate**

- **Coordination**
  - **OTL-309 gave strong support to the 3PT feasibility in the areas of time and procedure**
  - **Communications are not fully evaluated, but are not unique to requesting support from Tomahawk**

OTL 437 Objectives

- Use trained observers (SOF) to gather the target coordinates
- Send redirection tasking to the TA from SOF forces in the field
- Use aim point update to redirect an in-flight Tomahawk using SOF provided coordinates

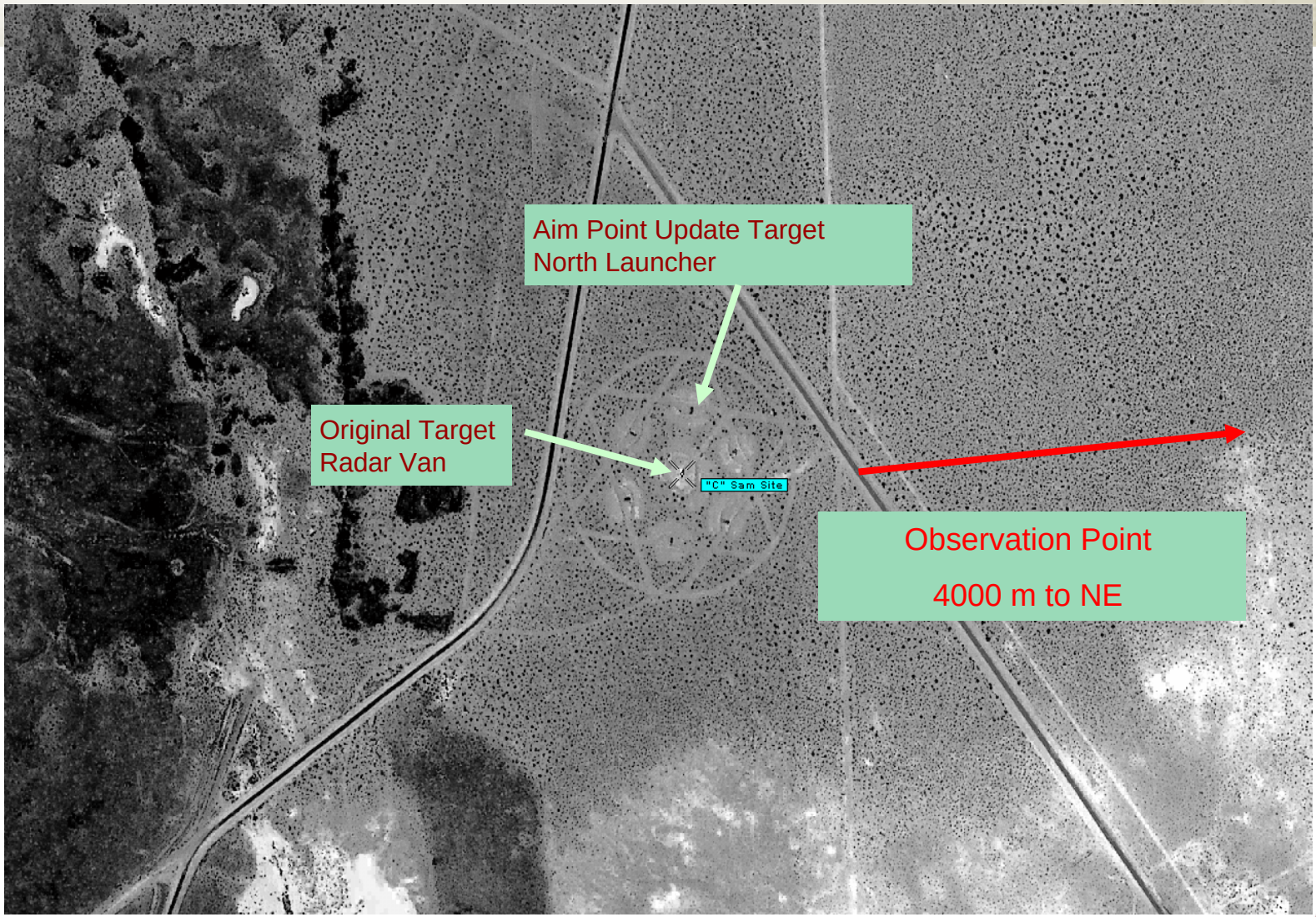
Targeting System Phase
Targeting Devices

LH-41C
Eye safe laser rangefinder
Integrated digital magnetic compass
Night vision enabled
External communication connector
GPS interface (PLGR or Garmin)

Vector / Viper
Eye safe laser rangefinder
Integrated digital magnetic compass
Night vision enabled
External communication connector
GPS interface (PLGR)

HPMF (High Performance Mobile FLIR)
Vehicle Mounted
FLIR Sensor
Image Intensifier
Laser Range Finder
Inertial Navigation System
Anti Spoofing GPS
Goal of 7m TLE at 7km

Targeting System Phase Layout
"C" SAM Site



Evaluation OTL 437 Objectives

- SOF have ability to provide acceptable Tomahawk coordinates from 4000m
- Not all equipment acceptable for Tomahawk 3PT
- Software improvements facilitated

OTL 454
JFCOM J9 Sponsored Live Retarget Event

- OTL 454 was first to demonstrate retargeting a Tomahawk in flight with coordinates gathered during the test flight
  - SOF team used hand held device to generate precision coordinates on an image chip. PFI (Precision Fires Image) viewer allowed operators to view the image chip using a PFED (Portable Forward Entry Device) and generate precision coordinates.
  - 9-line relayed from the field via PRC-117 to Tactical Operations Centers to Third Fleet for successful aimpoint update.

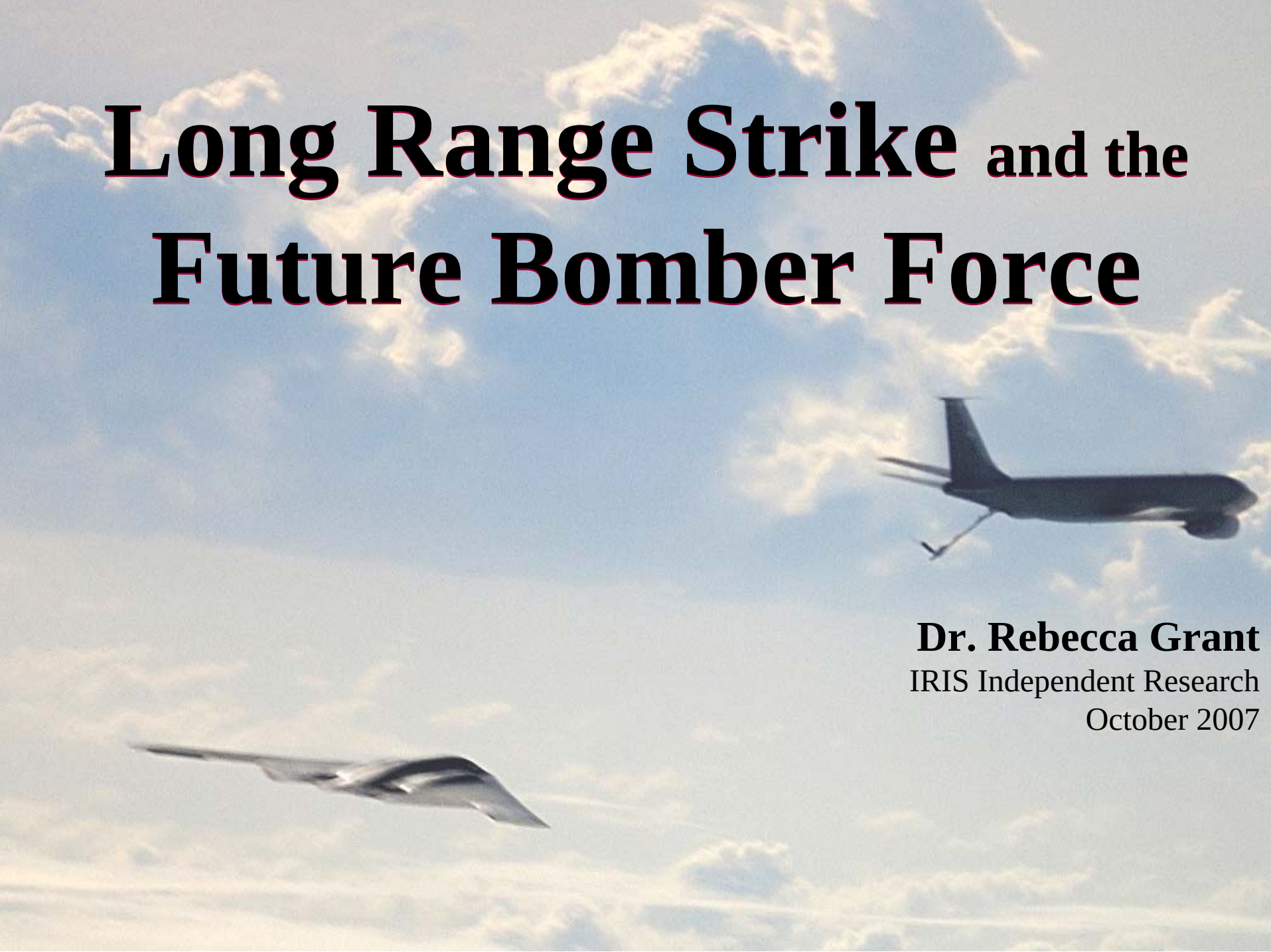
What Comes Next?

- Greyhound Express 08-01 in November 07 validates TTP, this time using non Navy SOF (JHAWK QRT)
- Greyhound Express in February 08 demonstrating Tomahawk targeting with UAS
- Use OTLs to develop techniques for BDII

Summary

- Greyhound Express provides validation of TTP with all portions of Tomahawk C2 except for the missile.
- OTLs – progressed from scripted to live.
- 3rd Party targeting capability of Tactical Tomahawk has been proven, and procedures are in place.

Long Range Strike and the Future Bomber Force



Dr. Rebecca Grant
IRIS Independent Research
October 2007

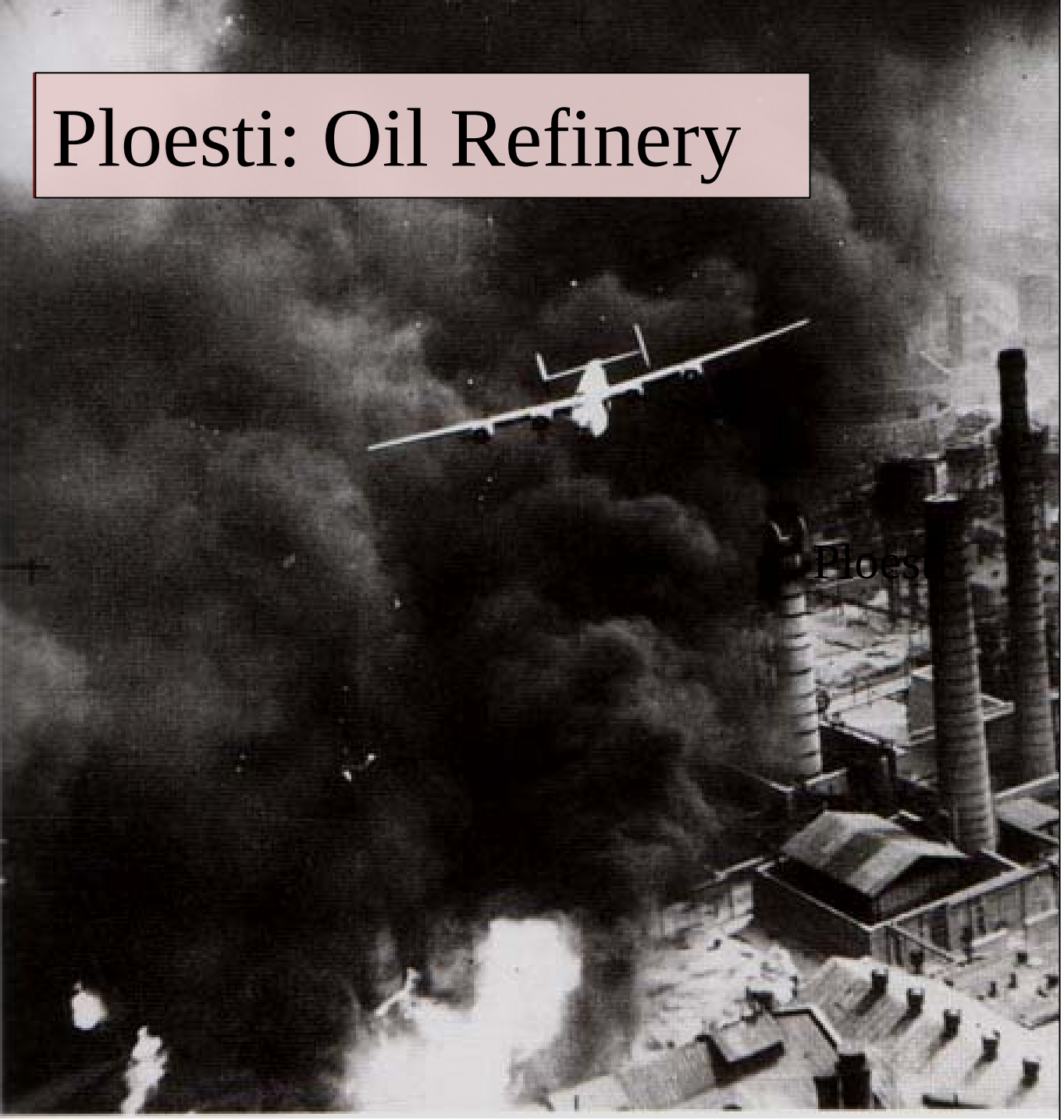
21st Century Priority

- **General Moseley:** "The soul of an Air Force is range and payload"
- **Secretary Wynne:** "I'd salt and pepper persistence in there as well"
- **Admiral Mullen, CJCS:** "Conflict in the future will most likely – but not exclusively – demand increased precision, speed and agility.
  - "Put in place a new concept of strategic deterrence for the 21st Century in terms of training, equipping, theory and practice appropriate to a range of state and non-traditional threats in both nuclear and conventional realms. – Chairman's Guidance, 1 Oct 07

Range, Payload, Persistence

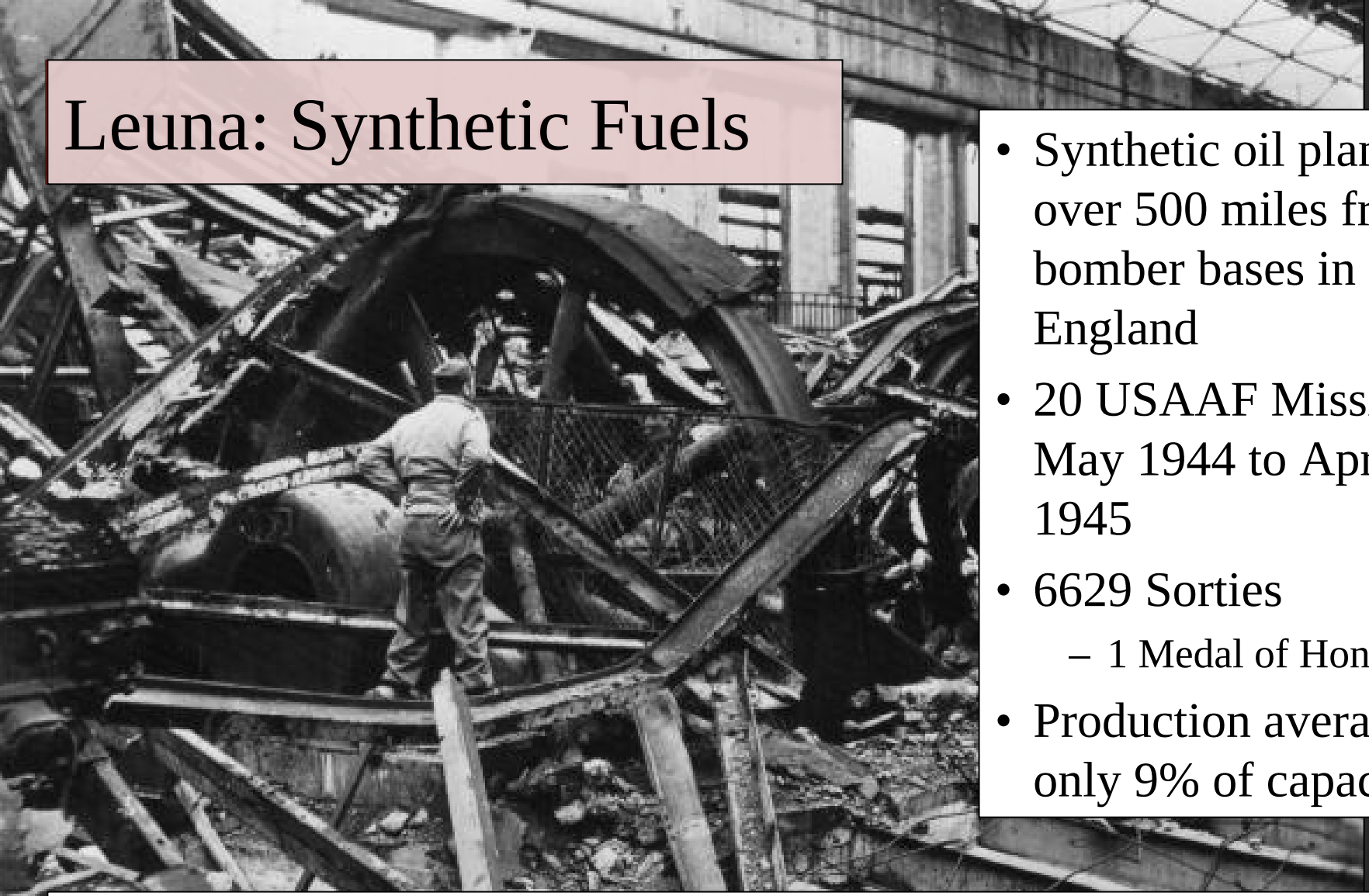
- **Joint campaigns demand attack on targets at long range**
- **The reach of airpower has been one of its defining characteristics since World War I**
- **Long-range strike a job for airmen**
- **Must hold at risk highly specialized targets**
- **Provide sovereign options**

Ploesti: Oil Refinery



- Critical deep target
  - Romania producing nearly half of Nazi Germany oil imports by 1941
- Far beyond reach of any other systems
- Expenditure of mission force acceptable if necessary
- 7 Medals of Honor
  - 5 for 1 Aug 43 mission

Leuna: Synthetic Fuels



- Synthetic oil plant over 500 miles from bomber bases in England
- 20 USAAF Missions May 1944 to April 1945
- 6629 Sorties
  - 1 Medal of Honor
- Production averaged only 9% of capacity

- Eisenhower on oil targeting: “This tactic had a great effect not only generally upon the entire warmaking power of Germany but also directly upon the front.”

LEUNA SYNTHETIC OIL WORKS AT MERSEBURG WRECKED BY 8TH AF AND RAF.

US AAF PHOTO 230-7

Cold War Deterrence

B-47s on the ramp in Morocco, 1956

- Nuclear deterrence dominated bomber requirements 1948 to 1988
- Only bombers could deliver long-range, assured penetration
  - Clear match of forces and effects
  - Recognition of unique bomber roles
- Bomber acquisition a top national security priority

Unique Bomber Roles

- Combined Bomber Offensive focused on priority military and industrial targets
- Greater range and payload = targets only bombers could strike
  - Most strikes on strategic and deep interdiction targets
- Many cases of strategic bombers in direct support of ground forces

Europe, 1944

Linebacker, 1972

The Big Change:1991-1992




Jan 1991:

- F-117s attack strategic targets in Gulf war
- Stealth, precision and effects-based operations

Dec 1991:

- End of the USSR
- Shift in nuclear deterrence mission

Jan 1992:

- B-2 cut to 21 aircraft*
- Decision created “bomber gap”

Jun 1992:

- SAC and TAC merge to form ACC
- Emphasized theater warfighting and effects

*21st aircraft added later

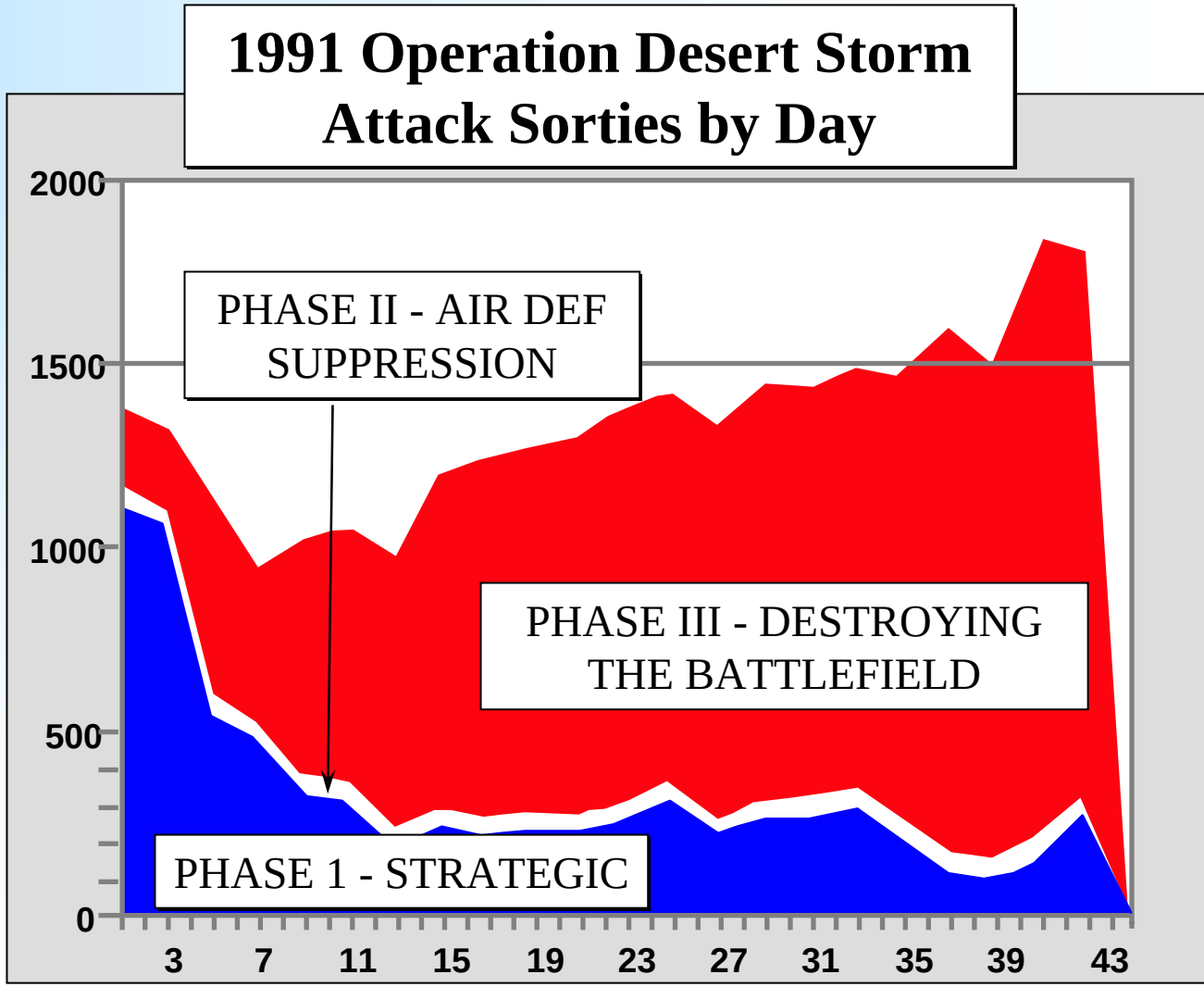
Risk Calculus in the mid-1990s

Undersecretary Kaminski, 1996:

- "We concluded from the **heavy bomber study** that with 20 B-2s, our bomber fleet size and mix will meet our mission needs."
- "When we examined the specific industrial capabilities needed for the B-2 and previous bombers, we found there is **not a unique bomber industrial base**."
- "The capabilities required to design, develop and produce bombers are **available in the broader military and commercial aircraft industries**. For example, all 54 of the key B-2 suppliers also supply other aircraft and/or other non-aircraft programs."

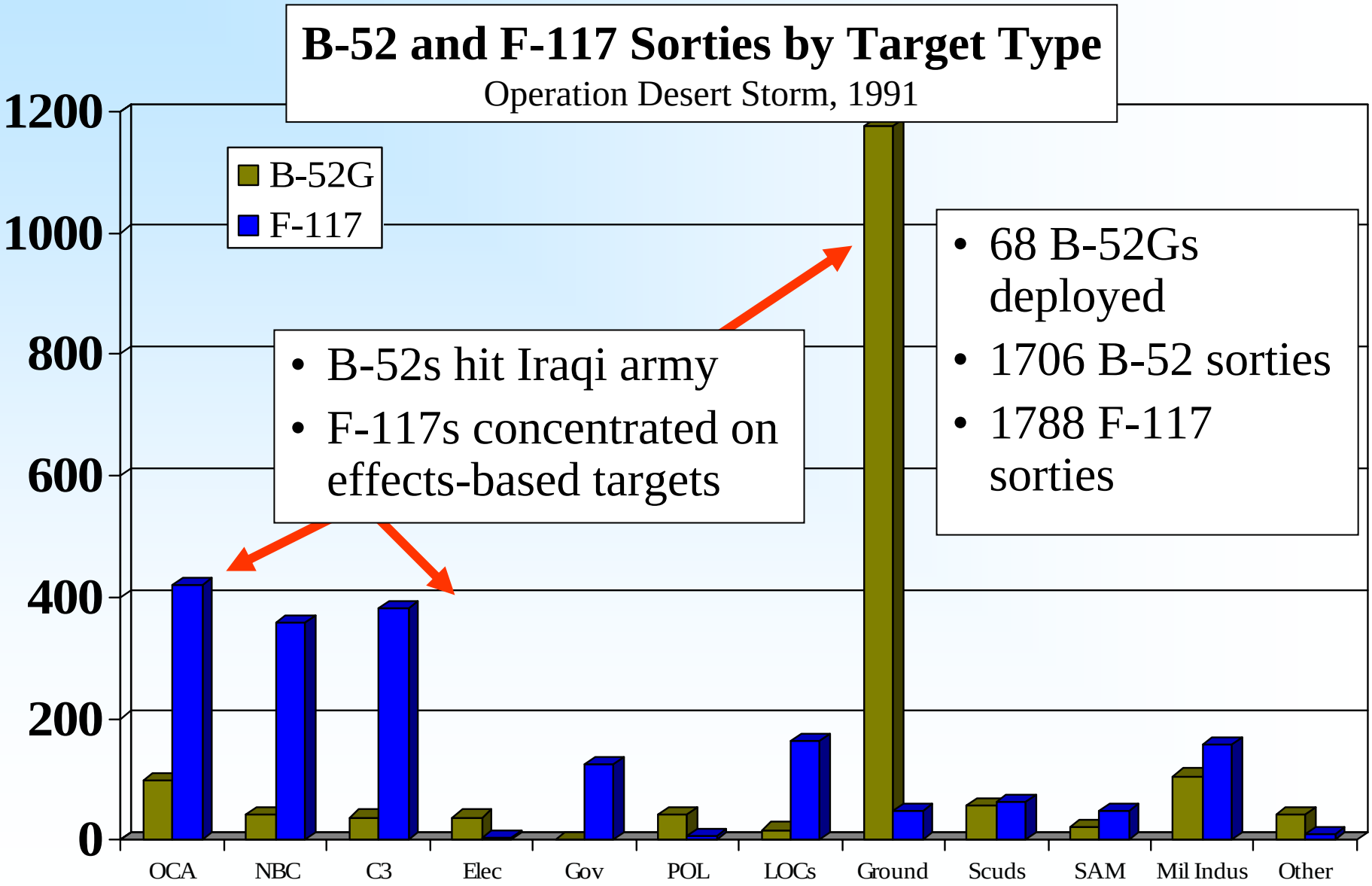
Analytic Perspective: Bombers in the Joint Campaign

- Aggregated campaign analysis for theater operations
  - Sorties as metric
- Precision revolution across all fighter platforms
  - Bombers got precision later*
- Effects-based targeting stressed value of precision over mass payloads



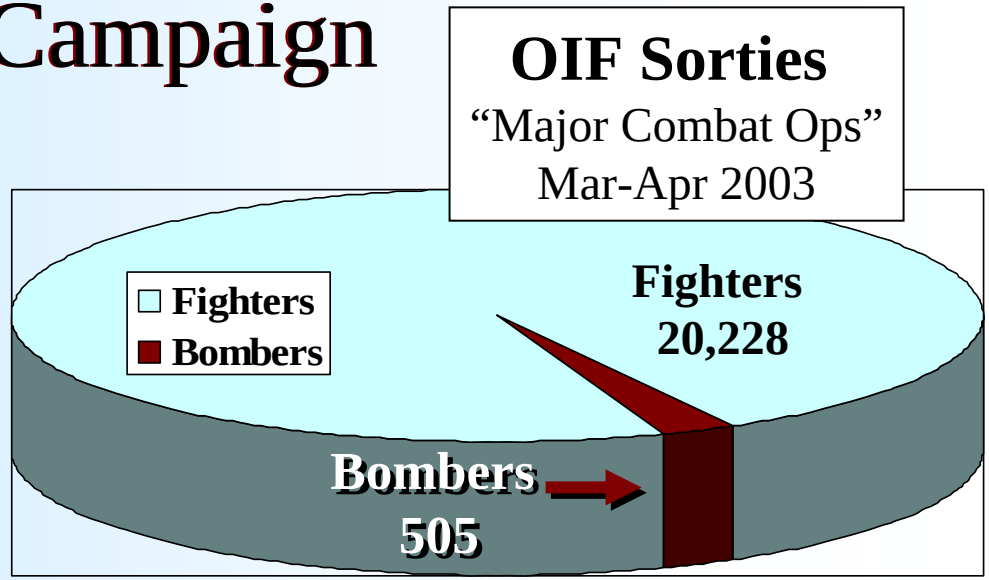
*Exceptions: CALCM, etc.

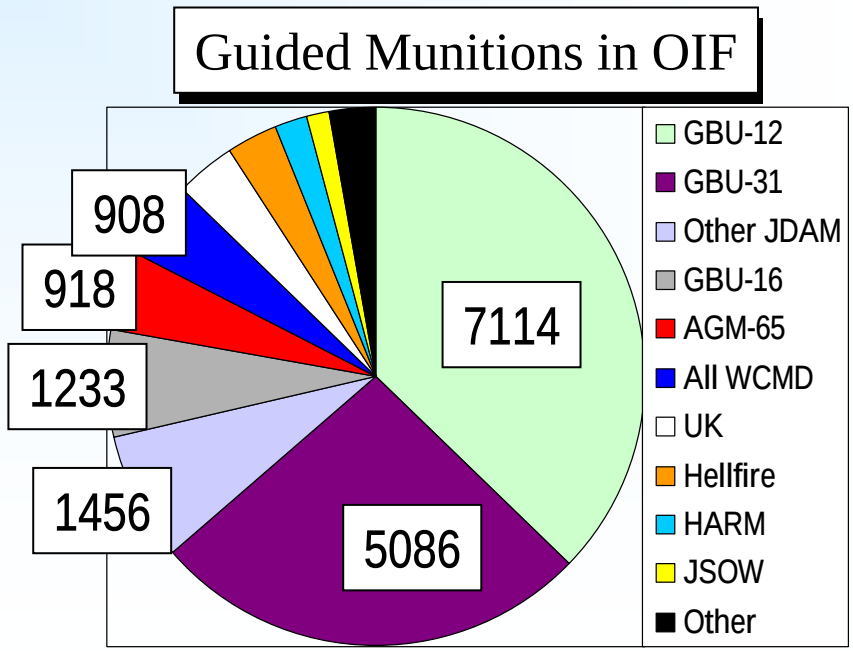
It’s the Effects…



Bombers in the 2003 Campaign

- Overall percentage of bomber sorties is small part of joint campaign
- Bomber **payload percentages** much higher
- Emphasis on effects not mass can obscure and minimize unique bomber roles in joint campaign analysis
- Diminishing returns in dense threat environment





Enduring Bomber Mission

- Strike any target, in any weather, anywhere, at any time, with high precision

Novi Sad Bridge

- B-2 debut as first all-weather precision bomber
- On many nights, B-2s were the only aircraft to drop bombs in high threat areas
- Total 97% successful firings of 609 JDAMs with 84% accuracy

Unique Bomber Roles

GWOT Roles

- Delivered about 70% of payload in OEF main combat operations
  - Weapons and communications upgrades made bombers essential to OEF
- Range and persistence for dominance in low-threat airspace
- **Stability ops…** B-1s and B-52s in daily close support for US & Coalition ground forces in Afghanistan

Unique Bomber Roles

Emerging Strategic Requirements

- Targets at long ranges in heavily defended airspace
- Immediate response targets
- Targets demanding constant overwatch
- Numerous aimpoints requiring simultaneous attack
  - Requirement for instant bomb damage assessment

Peer competitor?

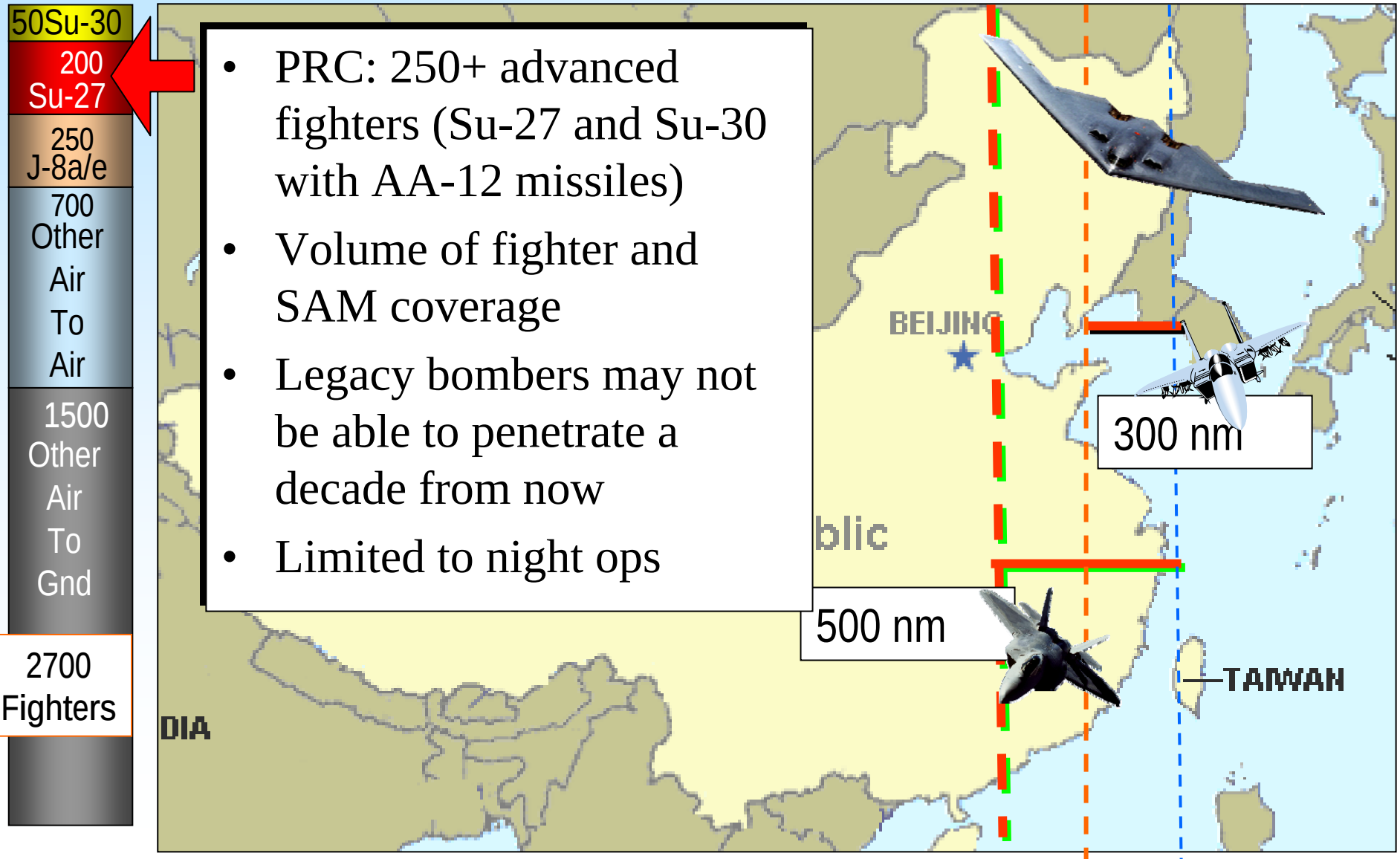
BEIJING

epublic

TAIWAN

- "Our national military strategy really requires deep strike capability effective in the face of anti-access limitations or the limited use of overseas bases." -- Maj Gen Jack Catton, ACC A8

Peer Competitor?



- PRC: 250+ advanced fighters (Su-27 and Su-30 with AA-12 missiles)
- Volume of fighter and SAM coverage
- Legacy bombers may not be able to penetrate a decade from now
- Limited to night ops

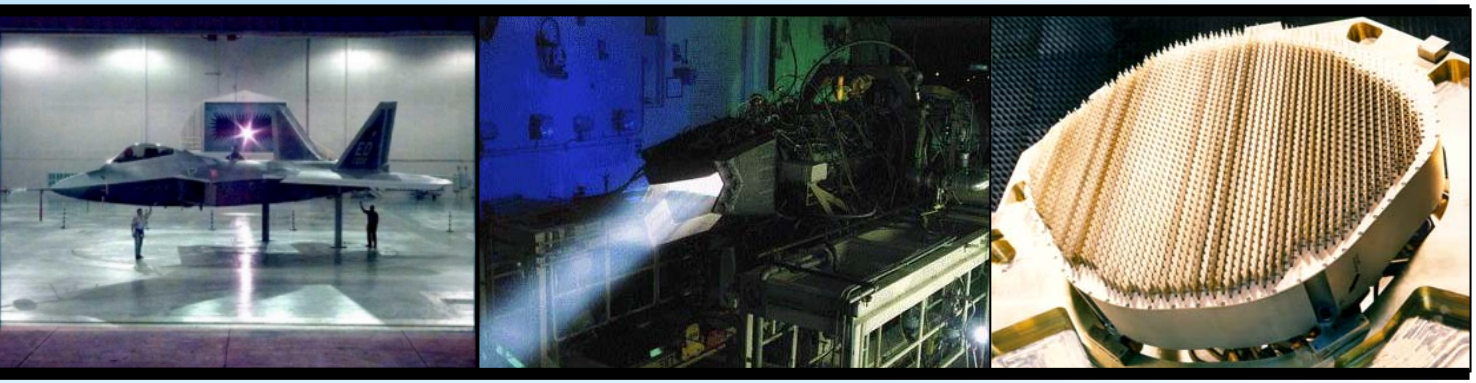
A New Bomber

- "We can stand off now with some of the finest aircraft ever built….But against a fifth-generation defensive system, this is not going to work for us. We need to be able to penetrate. We need to be able to capitalize on those attributes of an Air Force, which are range and payload and persistence. **So this takes us to a new bomber."**

  – *Gen Moseley, April 4, 2006.*

Range? Payload? Manned? Survivability? Subsonic or supersonic?

Ready to Go Now



- Improved stealth design and **materials**
  - Easier to maintain
- Composites

- Advanced **engine** derivatives for high subsonic speeds

- Radars, **sensors** and other systems

?

- What's Not
- Hypersonic platform
  - Weapons a good possibility
- Space transiting vehicle

Technology in Hand to Build a Superior New Bomber

Mach 3 Bomber?

- Supersonic club: B-58, B-70, SR-71, early B-1 prototypes
- Engine performance for Mach 2-3 amply demonstrated
  - Survivability questions
  - RCS reduction (B-1 changes)
- For a bomber, supersonic pay-off not the same as for a fighter
- Current choices:
  - ADVENT engine technology can optimize subsonic strike mission
  - Range penalty for supersonic strike

- Successful USAF test flights up to Mach 3 cruise in 1964-1966
  - Fatal crash of AV/2
  - Later flew with NASA
- Already becoming vulnerable to long-range, high-altitude surface-to-air missiles (SA-5 deployed 1967)

A New Bomber

Range:
- 3000 miles +

Speed:
- High subsonic

Persistence:
- Survivability for day and night attack

IOC:
- 2018

Payload:
- Precision and effect
- To include heavy penetrating weapons

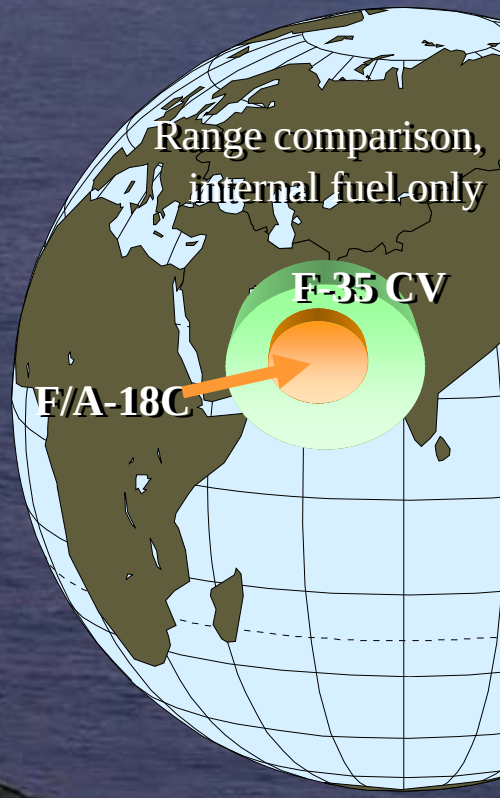
Sensors:
- Advanced, network capable, ISR, BDA

Fleet Size:
- About 100

Future Concept

- A bomber in name only
- Information-centered platform in “wolfpack” concept of operations with F-22, F-35, other systems
  - For survivability and mission success
- Optimized for mobile targets
- Capable of striking any target, anywhere, in any weather, with high precision

Options: CVN 21?



Complimentary capability

- **Enhanced strike platform**
  - **F-35 with longer mission radius**
- **Limits on payload and persistence**
- **Navy UCAS – potential for long-range strike**
  - **Surveillance variant ~2015**
  - **Strike/SEAD ~2020**

Conclusion: 2018 Bomber

- Top national security priority
- Exciting challenge for USAF
- Technology timing is right for a bomber to meet long range strike requirements

"As you probably know better than most, we would never have bought a single combat type, including the B-17, if we had waited for a better type we knew was just around the corner." -- Spaatz to Kenney, January 1947

Results of The Johns Hopkins University Applied Physics Laboratory's C2 Hypotheses Exercise

Presenter
Buck Buchanan
APL C2 Initiative Director
thomas.buchanan@jhuapl.edu
(443) 778-3865

APL Contributors
Steve Forsythe
Jim Hillman
Bob Leonhard
John Nolen

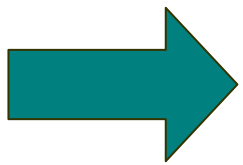
APL
The Johns Hopkins University
APPLIED PHYSICS LABORATORY

The Command and Control Challenge

- Inconsistent situational understanding within and between different command levels
- Limited ability to rapidly identify necessary participants across command levels for planning, action, and response
- Difficult to collaborate in an efficient manner to do dynamic planning
- Hard to receive rapid feedback to assess and adapt to emerging conditions and shorten timelines (e.g., time-sensitive targeting)
- Constrained ability to command in a dynamic environment

Sources: 9/11 Report, Operation Anaconda Report, FCS Requirements, USAF C2 FNA, JFCOM OIF Lessons Learned

Closing the Gaps



Moving from the "As Is" …

… Transforming to the "To Be"

C2 Operational Vision

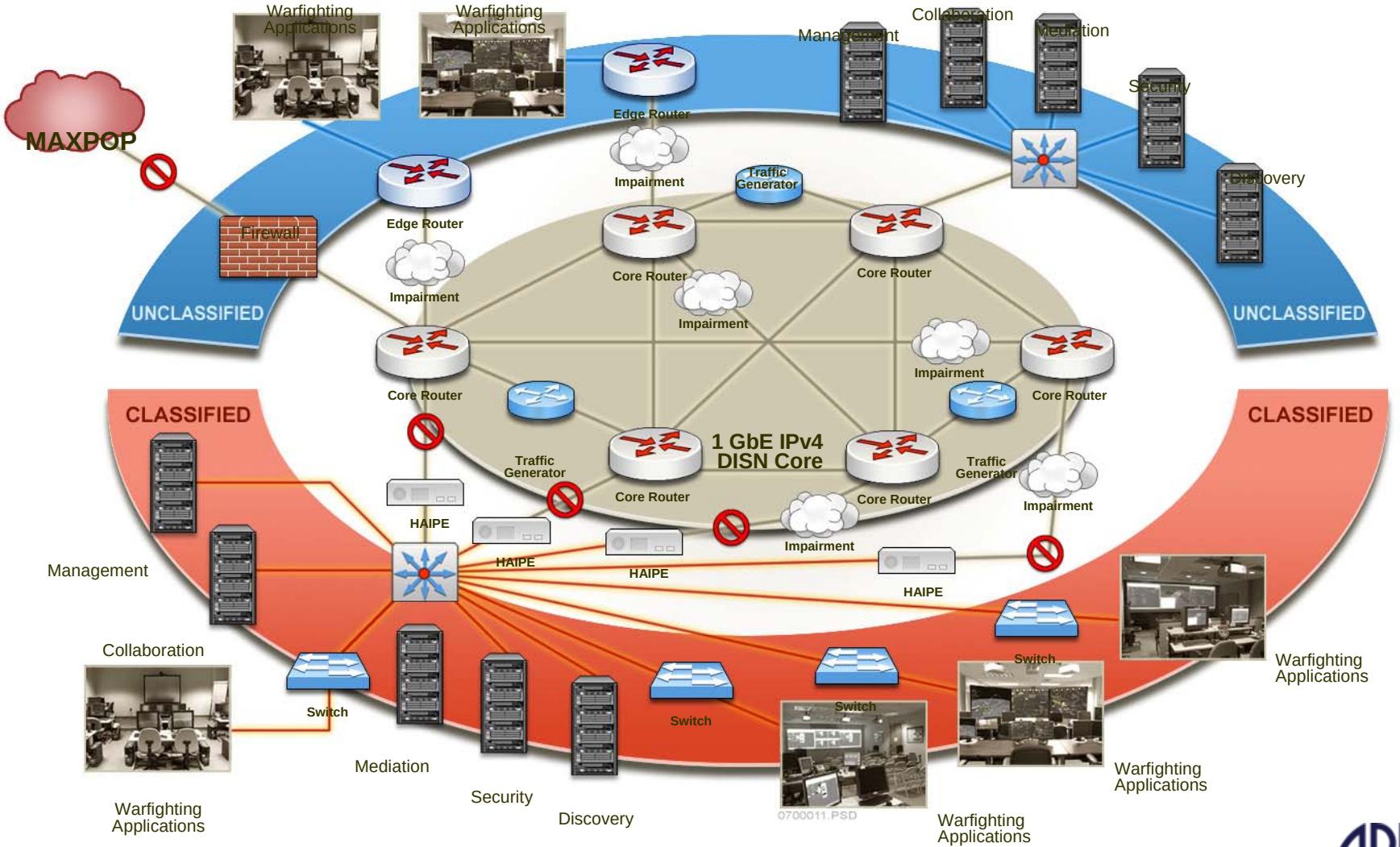
- A shared understanding of the battlespace including real-time coordinated interfaces between commands at all echelons
- Distributed/collaborative decision making across echelons, services, agencies, and coalitions
- Self-synchronizing forces enabling a command structure adaptive to the warrior/responders needs
- Decision making based on predictive and measured assessments of desired effects

One View Of Net-Centricity

“Reading current literature about net-centric warfare is like reading a math book with all theorems and no proofs.”

Anonymous

APL GIG Test Bed:
Technology Integration, Experimentation, and T&E



Some Lessons We Are Learning

- **Net-centricity represents a significant paradigm shift for warfighters and system developers**
  - **Changing the culture is as important as (and as hard as) developing required technical capabilities**
  - **Effectiveness needs to be demonstrated**
- **Quantification is essential to understanding C2 system performance**
  - **Metrics are needed at every level to establish the effectiveness of C2 concepts, technologies, and operational approaches**
- **Hands-on experimentation is critical**
  - **Exploratory development, test beds and ranges, exercises, and T&E are required to develop viable net-centric C2 foundations**

APL's C2 Operational Concept

Salient Features

- **Acknowledges complexity and diversity of conflicts/crises – the interaction of opposing considerations within unique operational environments**
  - **Conventional and Unconventional Warfare**
  - **Hierarchy and Anarchy**
  - **Knowledge and Uncertainty**
  - **Centralized and Decentralized Control**
  - **Concentration and Distribution of Combat Power**
  - **Proactive and Reactive Decision Making**

C2 is influenced by the operational environment and will vary over time and levels of war

APL's C2 Operational Concept (Cont'd)

Salient Features

- **Contemplates full spectrum of military activities**
  - **Presence, peacekeeping, and armed conflict**
  - **Coalition and interagency operations**
  - **Homeland defense**
- **Focuses on conceptual flexibility – the expectation that any operational environment is dynamic and that future C2 must also be dynamic**
- **Assumes future C2 must integrate emerging operating concepts with emerging technologies in four key areas:**
  - **Advanced Situational Awareness/Understanding**
  - **Decision Making**
  - **Planning**
  - **Execution**

Why a C2 Hypotheses WALEX (C2 HYWAL)?

???

ANALYSIS & EXPERIMENTATION

HYPOTHESES

Concept!

Solution!

The Problem:

Many agencies routinely offer technology demonstrations…

…but few ever progress to developing effective concepts and systematic solutions.

The Solution:

Concepts are assessed through viable analysis and experimentation…

…and the foundation of experimentation is a system of well thought-out hypotheses. Without hypotheses, experiments are nothing more than tech demos.

C2 HYWAL Objectives

- **Provide a forum for C2 Concept and Doctrine Stakeholders to influence evaluation of advanced C2 concepts and enabling technologies.**
- **Identify 3 – 5 high payoff, high risk Network Enabled Command and Control implementing concepts.**
- **Develop 2 operational hypothesis for each of the implementing concepts.**
- **Suggest an experiment focus and evaluation metrics for each operational hypothesis.**

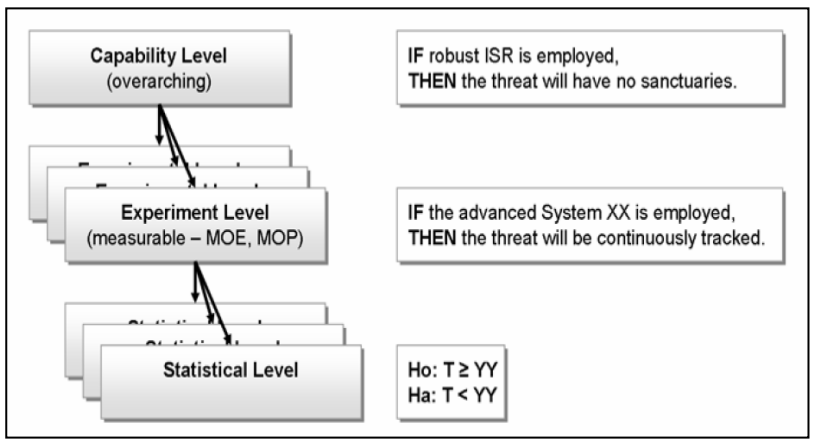
27 Total Participants

USAF
USN/USMC
MITRE
USJFCOM
JHU/APL

JOINT STAFF
NORTHROP GRUMMAN
BOEING

Kass Model - Hypotheses

It is useful to consider three different levels of ***warfighting experiment hypotheses***. At the most abstract level the if-then aspects are described in terms of capabilities and operational effects. These capability hypotheses, however, are not useful to experimenters who require hypotheses with implementable treatments and observable effects. The high-level "capabilities hypothesis" needs to be translated into one or more "experimental level" hypotheses. This is accomplished by translating the high-level capability into *enabling* systems that can be surrogated or modeled in an experiment.



--Richard A. Kaas
The Logic of Warfighting Experiments
CCRP, 2006

Kass Methodology

- **Begin with a restated *conceptual idea* derived from current literature**
- **Develop example *capability level hypotheses***
- **Develop example *experimental level hypotheses* *(these can be field experiments, tabletop experiments, or wargames)***
- **Develop example *statistical level hypotheses***

More on what we mean in a minute

Example of an Enabling Concept for Experimentation (1)

- **Conceptual Idea: "Shared situational awareness increases mission effectiveness."**
- **An operational setting:**
  - **SOF Team infiltrated by SSN to an Objective area**
  - **SOF team has direct control of a UAV and receives sensor data by direct downlink.**
  - **After SOF team is disembarked from SSN enemy forces are redeployed and target is moved**
  - **UAV Imagery confirms enemy / target movements**
  - **SOF team uses UAV data to avoid enemy forces and engage target.**
- **Desired operational outcome:**
  - **Ingress, target destruction and egress are successful**
  - **Overall mission is successful**

Back to the Kass Model Using Example

- **Conceptual Idea: "Shared situational awareness increases mission effectiveness."**
- **Capability Hypothesis: If UAV data is available to share, then military units will maneuver and fight more effectively.**
- **Experimental Hypothesis: If UAV data is available to a SOF team then the likelihood of detection will decrease and mission accomplishment will increase**
- **Statistical Hypothesis (one example): If the measured detection rate of blue forces with UAV data is less than the measured detection rate without predator data by a factor of two sigma or more, than the presence of predator data significantly reduced the probability of SOF team detection**

Example of an Enabling Concept for Experimentation (2)

CONCEPT: Shared situation awareness leads to increased self-synchronization and dramatic increases in mission effectiveness.

CAPABILITY HYPOTHESIS: If all members of a joint interagency task force have shared situation awareness, then reaction and decision times are greatly reduced.

EXPERIMENTAL HYPOTHESIS: If the commander employs liaison teams equipped with system X, then crisis response teams will react faster to emergencies.

STATISTICAL HYPOTHESIS: If system X equipped liaison teams are fielded with PVOs, then intelligence tips from PVOs will increase.

SCENARIO: US/Coalition interagency task force conducts humanitarian relief following severe outbreak of cholera in major urban area. Low-level insurgency threatens peaceful recovery. World community interested; many NGOs/PVOs committed to relief efforts.

COMMANDER, US FORCES has several options for C2 organization, including the capability to provide liaisons and equipment to share situation awareness among all joint, interagency, and coalition partners, in addition to selected NGOs/ PVOs.

WARGAME tests various options and their outcomes through the use of an event list that presents insurgent attacks, interaction with host nation government and groups, and disaster relief requirements.

This scenario explores the C2 Concept dynamics of *hierarchy and anarchy*, and *centralized and decentralized C2.*

C2 HYWAL Group Tasking

- Group #1 - Look at problems associated with vertical / horizontal C2
- Group #2 - Look at a constrained environment
- Group #3 - Look outside the box
  - Identify 3 – 5 high payoff, high risk Network Enabled Command and Control implementing concepts.
  - Identify 2 operational hypothesis for each of the implementing concepts.
  - Suggest an experimental design and evaluation metrics for each operational hypothesis.

Top Six Hypotheses

H#	Averages in Quartiles Across Matrix (highest is best)	Priority
20	If we improve our ability to share learned success (and failures), then we will be more adaptable to a rapidly changing environment. (Group 3)	4.00
14	If we improve our sensing and understanding of non-physical domains, Then we will create new action options for ourselves, better understand how to eliminate the enemy's options, and better predict the outcome of our actions (Group 3)	3.90
3	If the same actionable data is available to the entire command structure, then there is improvement in horizontal and vertical coordination that enables decision-makers to operate inside the enemy's decision cycle resulting in achieving desired effect (Group 1)	3.90
6	If provided a collaborative environment tailorable to decision-makers, the quality of decision will be increased. (Group 1)	3.90
15	If we understand the enemy and the environment, then we will be able to turn the enemy against himself. (Group 3)	3.80
19	If we can influence the opponents through cyberspace, then we can effect operations anywhere in the world. (Group 3)	3.80

Applying Kass Model to our Highest Priority Capability Hypothesis

Capability Hypothesis : ***If we improve our ability to share learned success (and failures), then we will be more adaptable to a rapidly changing environment***

- **Experimental Hypothesis #1: Given a blog platoon leaders read to gain latest insight into Techniques, Tactics, and Procedures (TTPs) appropriate for his/her situation, if blog had monitor/editor, then feedback loop will be improved and platoon leaders would implement improved TTPs**

- **Measures: Ratio of good to bad data in blog, probability of implementing bad TTP rather than an improvement because of blog**

- **Discussion:**
  - **Blogs currently provide a feedback loop to allow platoon leaders (and others) to exchange information about did/didn't work**
    - **Clearly a tradeoff between validating and vetting ideas and suggestions versus a free flow of information**
  - **Experiment would attempt to measure effect of providing a monitor/editor to improve blog information content**

Applying Kass Model to our Highest Priority Capability Hypothesis (Cont'd)

Capability Hypothesis : ***If we improve our ability to share learned success (and failures), then we will be more adaptable to a rapidly changing environment***

- **Experimental Hypothesis #2: For platoon leaders in the field utilizing a blog for TTP updates, if a blog rates the effectiveness of posts, then the feedback loop will be improved and platoon performance improved**

- **Measures: Ratio of good/bad data, platoon performance parameters / metrics**

- **Discussion: Similar to experimental hypothesis #1, but it attempts to quantify value of allowing bloggers to identify important and useful information (as well as identify bad or wrong information)**

Applying Kass Model to our Highest Priority Capability Hypothesis (Cont'd)

Capability Hypothesis : ***If we improve our ability to share learned success (and failures), then we will be more adaptable to a rapidly changing environment***

- **Experimental Hypothesis #3:** **If separate repositories of Lessons Learned are automatically combined into a single, integrated, rated data repository and made available to exercise participants, then effectiveness of the forces will be improved**

- **Measures:** **Percentage of duplicates, percentage of contradictory lessons, utilization of lessons learned, number of events where lessons learned were not applied**

- **Discussion:** **Similar to experimental hypothesis #1 and #2, but attempts to measure value of integrating current "blessed" repositories of lessons learned and thereby maximize their usefulness**

Summary / Conclusions

- Conference objectives were intended to be bold
  - Engender collaboration between C2 theorists, technologists, and practitioners to influence evaluation of advanced C2 concepts and enabling technologies
  - Rich exchange of views and collaboration
  - Results serve as a basis for future C2 research and collaboration
- Central premise was a set of C2 hypotheses could be derived and serve as basis of future C2 testing and experimentation
- Challenging to link operational hypotheses developed experimental hypotheses, experimental venues, and metrics
    - More time / effort needed for this task than was available
- The Kass method was successfully demonstrated for C2 hypotheses development

Summary / Conclusions *(cont'd)*

- Noted challenge bridging so-called "air gap" between theoretical and testable
  - Two basic testing / experimentation approaches recommended
    - Narrowly define experiment into testable metrics
      - Drawback: scoping experiments to that which can be tested, the hard-to-measure virtues of shared awareness, self-synchronization, and collaboration (particularly across a large C2 enterprise) may be lost
    - Measure innovations in terms of adoption
      - If users see value, measured or otherwise, they will adopt innovations
- Military transformation of C2 probably requires a mix of quantitative and qualitative analysis to identify key capabilities
  - Testing hypotheses such as these could lead to more informed decisions regarding C2 solutions, balancing capabilities with resources, and identifying key areas for innovation
- Now looking at possible venues to carry on the initial progress made at this conference

JOHNS HOPKINS
UNIVERSITY

Applied Physics Laboratory

Raytheon

Customer Success Is Our Mission

Can Real-Time Operate in an SOA Environment?

Precision Strike Technology Symposium

Charles Kille, Raytheon
John Link, VOLVOX, Inc.

October 23-25, 2007

Outline

- Real-Time in the Net-Centric/ SOA Transformation Environment
- The Net-Centric/SOA Paradigm
  - Network and Net-Centric Definition
  - SOA Definition
- The Real-Time Paradigm
- When Paradigms Collide
- Recommendations
  - Policy
  - Network Architectures
  - Technical Solutions
  - Policy & Culture
- Summary

Our Question…

- Started with the abstract question: ***Can "Real-Time" Operate in a Service Oriented Architecture (SOA) based Operational Environment?***
- Refined the question to: ***Is Real-Time part of the Net-Centric/SOA Transformation Environment?***

Short Answer is, Yes… It must be, but there are issues…

As DoD moves forward with Net-Centric Transformation focusing on SOA and shared services as architectural choices -- significant concerns remain for the DoD enterprise and its mission-critical timing-sensitive needs, and for the Real-Time Community

Policy, Architecture & Technology Must All Support Net-Centric/SOA Transformation & Mission Critical Real-Time Operations

Net-Centric/SOA Concerns

To prepare the ground to examine the Real-Time Community concerns about Net-Centricity/SOA, let's first clarify some related terms:

- Network-Centric
- Net-Centric
- SOA

Net-Centric/SOA Paradigm
Definition: Network-Centric

Network-Centric Warfare: "NCW relies on computer processing power and networked communications technology to provide a shared awareness of the battlespace for U.S. forces."

Network Centric Warfare: Background and Oversight Issues for Congress CRS, June 2004

Network-Centric Warfare worked to aggregate existing "stove-piped" networks and applications at multiple operations centers to facilitate C2 joint forces through information superiority.

…Often called by Warfighters "Swivel Chair Integration"

Architecturally, Network-Centric systems are available to Commanders and analysts, separate but collocated, and primarily accessible in a Tactical Operations Center setting.

Net-Centric/SOA Paradigm
Definition: Net-Centric

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- ***Net-Centricity is an "information sharing strategy"*** **promoting:**
  - Secure connectivity and interoperability
  - Common technical standards
  - Common data and meta-tagging standards

- **Net-Centricity builds on the Network-Centric approach**
  - Net-Centricity leverages and extends connectivity and access to provide a much greater level of integration of services, information and interoperability -- across the Battlespace
  - Net-Centricity essentially mimics the seamlessness of the Internet solution space

Net-Centric/SOA Paradigm
Definition: SOA

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Service-Oriented Architecture (SOA) involves:

- "(SOA is) the policies, practices, and frameworks that enable distributed application functionality to be provided and consumed as sets of services. Services in SOA are published, then discovered and invoked by service consumers at appropriate granularity levels and are abstracted away from the implementation using a standard-based interface definition to produce effects consistent with measurable preconditions and expectations"

  NCES CDD, adapted from CBDI Forum www.cbdiforum.com, also quoted by NCOW 1.1

- SOA shifts the focus further from large tightly-integrated (tightly-coupled/ stovepiped) systems to policy- and standards-based services

- SOAs deliver capabilities for enterprise-wide solutions that are (or appear to have been) designed, developed, deployed as an integrated set of products that can be matured and maintained over longer periods

Services and Consumers Interoperate through Well-Defined Interfaces

Net-Centric/SOA Paradigm
VENN Relationship

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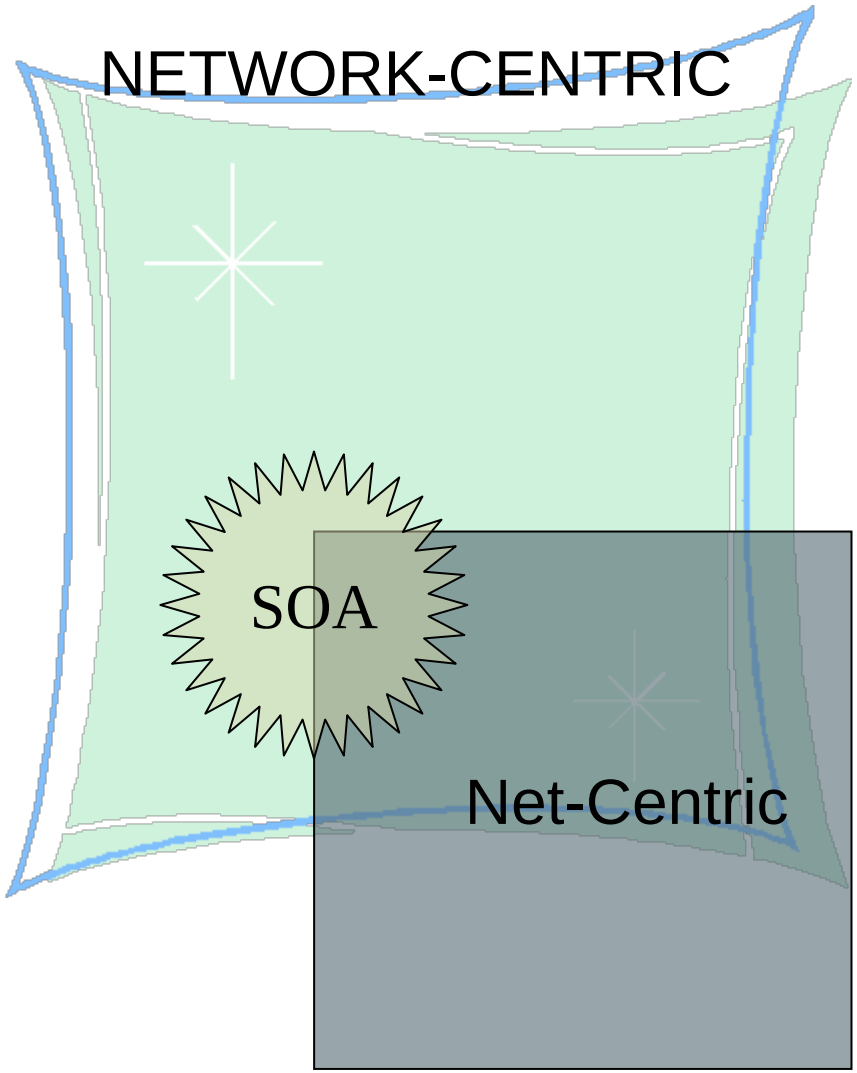


- **Network-Centric** systems and **Net-Centric** systems exist on a spectrum and are not mutually exclusive
- **SOA** rides on and takes advantage of either context
- SOA focuses on the information system…the complex software-intensive system/ services/ capabilities
- ***This expanded information-sharing capacity has serious implications for the Real-Time Environment***

Real-Time Paradigm

The Real-Time Paradigm includes:

- **Validity of an Operation (Mission Success) predicated on:**
  - logical correctness -- the right data
  - delivery within defined timing constraints -- the right time

- **Timeline and time-scale constraints imposed by external conditions**
  - Dictated by one or more monitored or controlled physical processes or mission need-lines (threads)
  - Constraints satisfied for proper system behavior
  - Implementation deterministic… predictable… controllable

Implication – Significant Consequences for Breeches

Real-Time Paradigm

- **The Real-Time Paradigm includes vectors of speed, determinism, predictability, assurance, and reliability.**

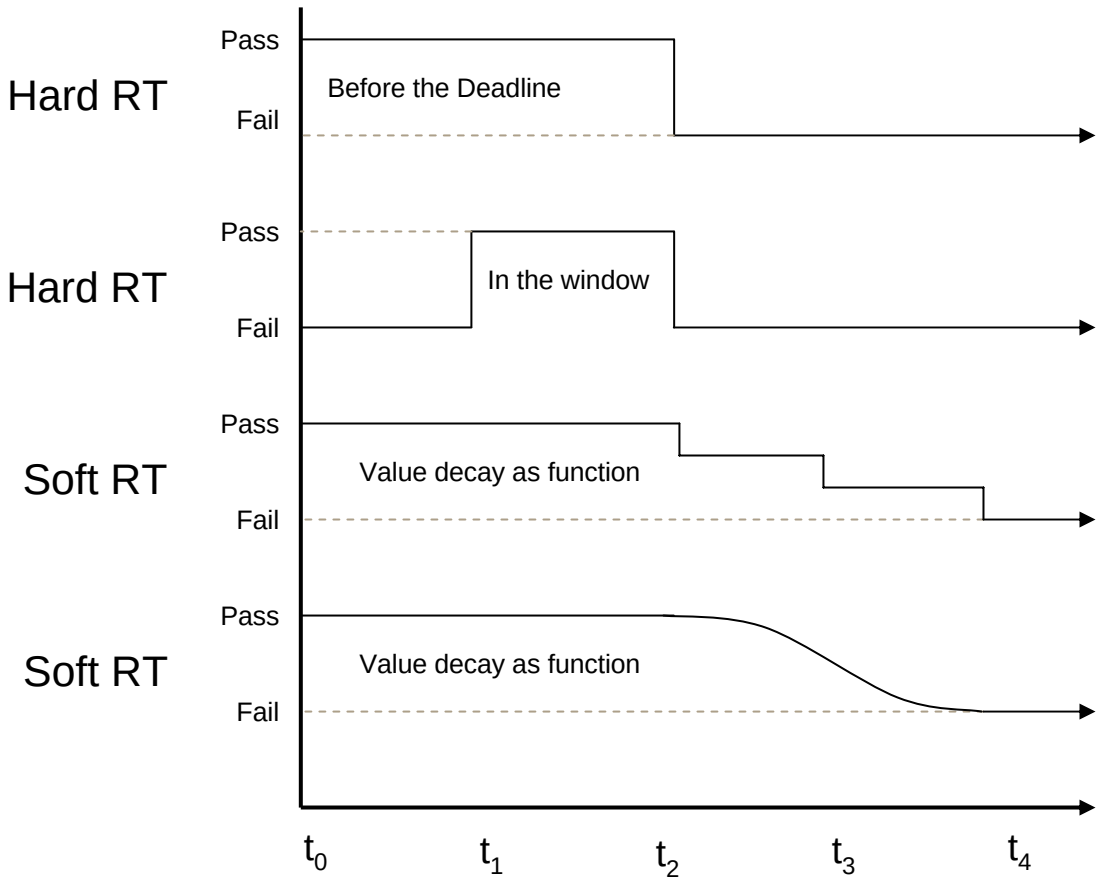
  - **Hard real-time:**
    - Value/validity of results is nil if timeline is breeched – *Late is Wrong*
    - Value curve looks like a step function

  - **Soft real-time:**
    - Value/validity of results diminishes over time or if timeline breeched
    - Value/validity reaches nil at some finite time

  - **Near real-time:**
    - Used to indicate longer timelines or interrupted timelines
      (man or IP-network in the loop)

  - **Non-real-time:**
    - No such thing (for non-trivial processing)

Value Pattern for Real-Time Paradigm



Time values for t_N can be µsec, msec, seconds, minutes, hours…

Real-Time Is Right Time, Not Real Fast!

Real-Time Paradigm (cont'd)

Real-Time Continuum *Real-Time deadlines and timelines imposed by constraints outside control of the computer/ software*								
Near Real-Time (Some Latency Acceptable)			**Soft Real-Time**			**Hard Real-Time**		
Involve longer timelines (or interrupted timelines) and often entail planning cycles			*Deadlines are tight but not necessarily absolute; "value" of a computation diminishes after deadline expires*			*Deadlines must be satisfied for proper system behavior; processing timelines must be deterministic; "value" of computation is nil after deadline expires*		
Examples of Real-Time Patterns								
Logistics	Personnel	Fiscal	C&C	Intelligence	Medical	Time-Sensitive Targeting	Sensor/ Machine Control	Effector/ Flight control

Example 1- NASA Real-Time Scenario

Rocket Engine controller

- The space shuttle main engine controller needs to produce a set of commands for fuel flow valves every 5 ms. Miss one and the engine will burn through. Do them too fast and the control laws (being Z transforms) are incorrect.
- A discrete machine control loop, operating significantly close to the limits of digital control processor response times.
- The objective must be accomplished within a specified time window, or fail.
- Failure carries significant consequences.
- No Question of the Real-Time Pattern or status of this scenario…

Example 2 - Effects on Time on Target Real-Time Scenario

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Effects on Time on Target in Theater

- A fighter-bomber mission to interdict traffic thread requires an effect on a specific target set within a specific window of time
- Must orchestrate command and control, sensors, and effectors of a system/enterprise to be sure the effect is correctly applied
- The specific success window, from a few seconds to a few minutes or even hours
- The window may be offset in time based on a decision cycle or set of trigger events or other guidance
- Success criteria are obviously set externally to the system
- The effect of arriving too soon or too late is a failure with dire consequences...
  - -- The effect might be applied to a wrong target, possible friendly, or applied to no useful target.

Analysis of the Real Time Scenarios

- In each case we have the same Real-Time Pattern defined by success/failure criteria that follows the second Hard Real-Time Pattern of a validity window.
- Each has significant consequences for failure.
- Each has a significantly different time scale… by orders of magnitude
  - Time scale drives trades, timing and sizing studies, significant design choices

Analysis of the Real Time Scenarios (cont'd)

Each Scenario presents unique issues for design and implementation but the Real-Time Pattern is inescapable

- **The first Scenario -- NASA machine control:**
  - Is a pattern industry has considerable experience with
- **The second Scenario -- Effects on Target:**
  - Involves a Net-Centric enterprise which presents a solution space with less experience to draw on, as an integrated Net-Centric solution
  - Made more difficult as consists of services, infrastructures, heterogeneous computing
  - Also includes integrations of products from multiple venders and/or programs that will change asynchronously over time

When Paradigms Collide!

- Core of the “collision” -- as more services and operations move to a common network of networks -- potential risk that Real-Time Operations are likely to suffer due to increases in bandwidth constraints (GIG-BE notwithstanding) if networks are not judiciously-engineered and managed

- Concerns and resulting resistance to the Net-Centric/ SOA Transformation paradigm by the Real-time Community risks slowing the momentum of Transformation efforts -- albeit for very sound, observable reasons

- In progression from Network-Centric (“Swivel-Chair engineering”) to increasingly Net-Centric and SOA environments (real integration and interoperability), the Real-Time Community considers itself isolated

Recommendations Intro

- Since the Real-Time and Net-Centric/SOA communities must work together to provide critical Warfighter mission needs, the current gap in understanding and cooperation between these two vital communities must be bridged through:
  - Policy
  - Cultural Dynamics
  - Network Architectures
  - Technical Solutions

Recommendations: Policy

- DoD and the Services and the Real-Time Community need to create together agreed-upon typology, sets of standards, and architectural patterns for the Real-Time Community

- Policies that support the Net-Centric/SOA paradigm need to include the establishment of strategies and Advisory/Oversight bodies dedicated to support the Real-Time problem space
  - Network Strategies
  - Service Interface/Interoperability and Deployment Strategies

- The Real-Time Community and the Net-Centric/SOA Community are both integral to the DoD enterprise and need to collaborate actively in continued development of Net-Centric transformation policy through emerging CONOPS, Architectures, and Design Patterns

Define Needs - Set Goals - Drive Solutions

Recommendations: Cultural Dynamics

- Changes in policy, network architectures, and technical solutions are inter-related, interdependent, and dynamic:
  - Policy provides over-arching guidance
  - Architectures inform design and 1st step to technical solutions
  - Technical solutions embody design and implementation in alignment with architectures and specific mission needs
- The Real-Time and Net-Centric/SOA Communities need policy mechanisms to work together for best approaches
- As with many new directions in DoD -- in addition to changes in policy, architecture, and technical solutions -- culture change will be needed on the part of both the Real-Time Community and the Net-Centric/SOA Community

Recommendations: Network Architectures

- Real-Time Separation:
  - The use of dedicated network structures is one solution to insure QoS for Real-time users
- Real-Time Enclave through Segregation:
  - Segregation includes the set solutions that include VPN, “tunneling” and Encryption of “network routes” on existing networks.
  - This is a less robust solution but one that lends itself to more Net-Centric Architectures
- Analysis of Enterprise Networks to determine if current bounded areas are the result of Network Separation or Virtual Segregation -- critical because Virtually-Segregated networks can lose QoS due to others’ networks on the same backbone

Recommendations: Network Architectures (cont)

- Policy & Network Architectures:
  - Product development/design/deployment cycle support:
    - Policy that directs adherence to Network Architectures
    - Architectures that push run-time design choices as late as possible in the cycle facilitate service discovery, lead to less redesign and rework, and increase flexibility
- Network Isolation or Separation must be:
  - Pushed down to the lowest level of granularity, so that Real-Time needs don't Balkanize the emerging Net-centric DoD Enterprise
  - Tempered by organizational needs and mission success goals
  - Provide accessibility for mission critical information/command flow

Recommendations: Technical Solutions

- Infrastructure and Applications that prioritize Real-Time and Time-Sensitive packets over shared networks either using some kind of route management or on the fly compressions
  - Assumes viable, multi-phase network strategy that considers
    - Design Time
    - Integration Time
    - Pre-Deployment and Deployment Orchestration Time
    - Run-time Management

Summary

- To achieve success, Real-Time mission-critical operations must *engage* in dialogue and policy development with both:
  - Traditional Real-Time Communities
  - Net-Centric, SOA Communities
- Technical solutions must be developed to allow Real-time network management
- Network segregation or separation must be:
  - Pushed down to the lowest level of granularity to avoid “Balkanization” of Net-centric enterprise
  - Tempered by mission needs and success goals
  - Provide accessibility for mission critical information/command flow, and not for sake of organizational turf
- Real-Time components must live within the Enterprise need-space and interoperate as a service
- Net-Centric Enterprises need to move forward, respecting Real-Time component constraints

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Questions and Discussion

Enabling Emerging Technologies and Technical Solutions for the Defense of Our Nation

Captain Chuck Nash USN (RET)

President, Emerging Technologies International Inc.

GOALS

- Define the Problem (Nothing New Here)
- Discuss the Environment (Significant Changes Here)
- Show Historical Examples (Fun stuff)
- Suggest Solutions

DoD Budget and Planning Process

Faced with a 20-year threat,

the Gov't responds with a 15-year plan;

Programmed in a 6-year POM;

Managed by 3-year personnel;

who develop a 2-year budget;

funded by a 1-year appropriation;

formulated over a 3-day weekend;

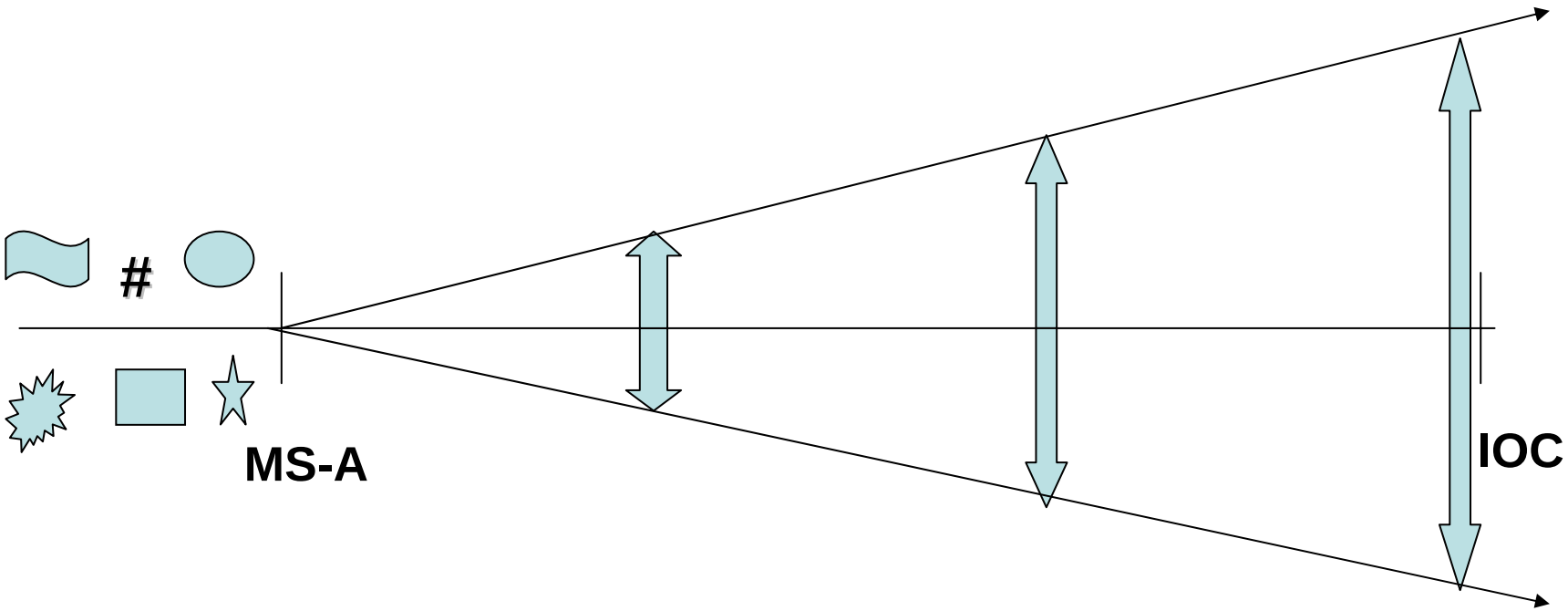
and approved in a 1-hour decision brief.

Five Reasons Programs Go Off Track

- Unstable requirements
- Faulty cost estimates
- No test buy in
- Inadequate system's engineering
- Unstable funding

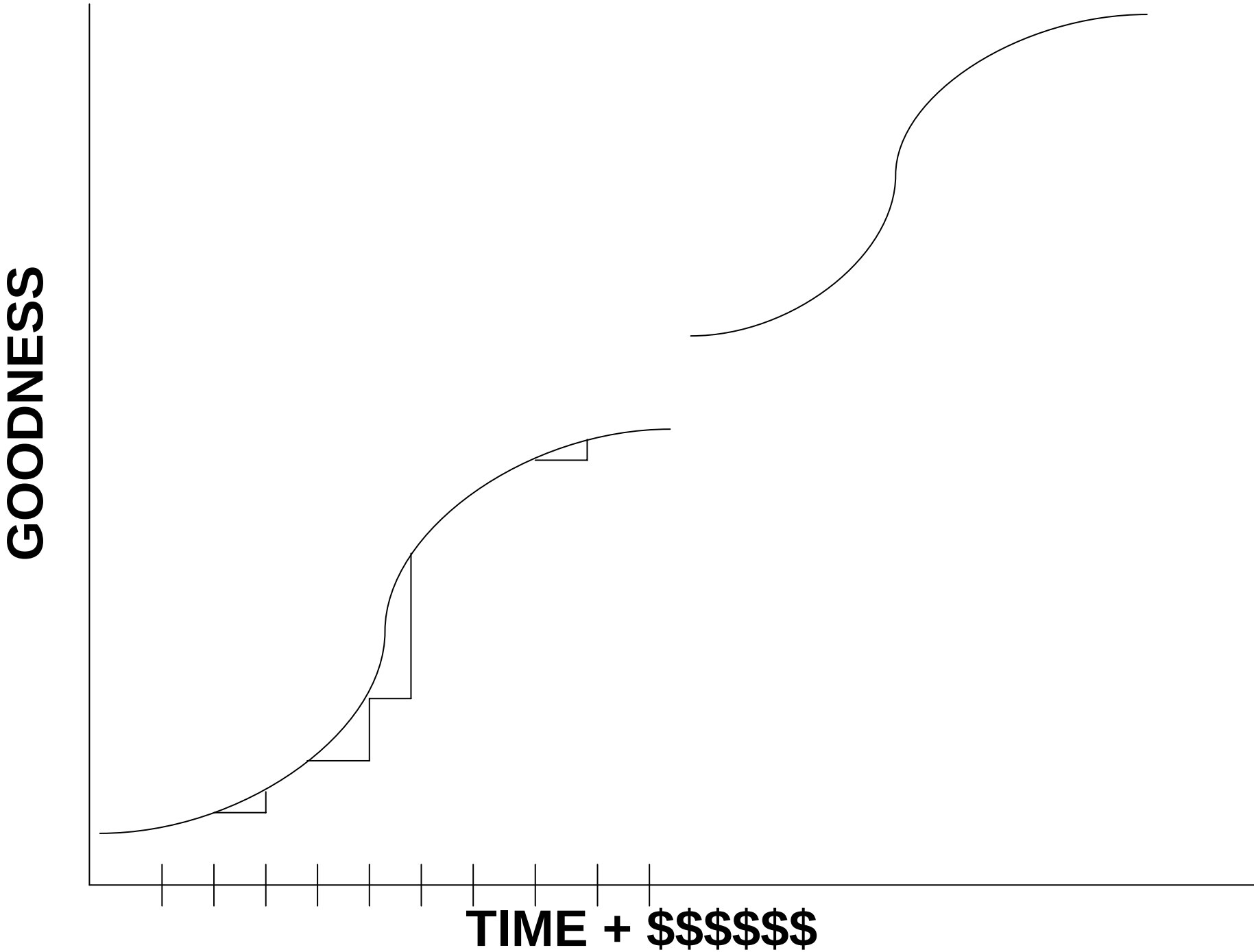
OUR OWN PROCESSES CAUSE THESE PROBLEMS – DOING WHAT WE DO NOW FASTER WON'T FIX IT

ONE Development Cycle = 11.5-15 years*



10+ years ⟷ 12 years

* Gansler memo Jul 99 says 11.5 yrs, GAO MAR 06 report says 15.3


GOODNESS
TIME + $$$$$$

1908 Galloway Truck

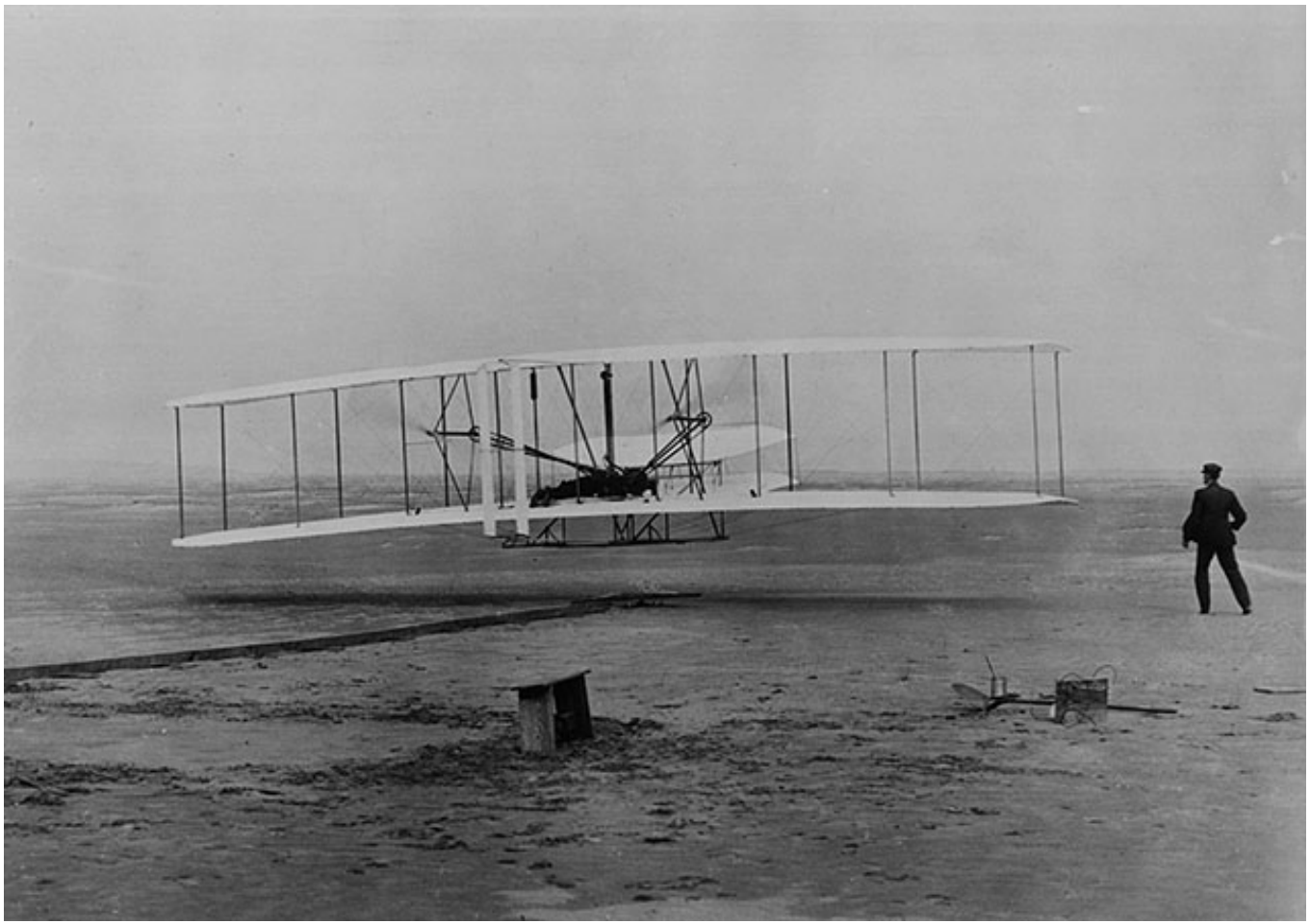
1910 Sears

1915 Ford Towncar

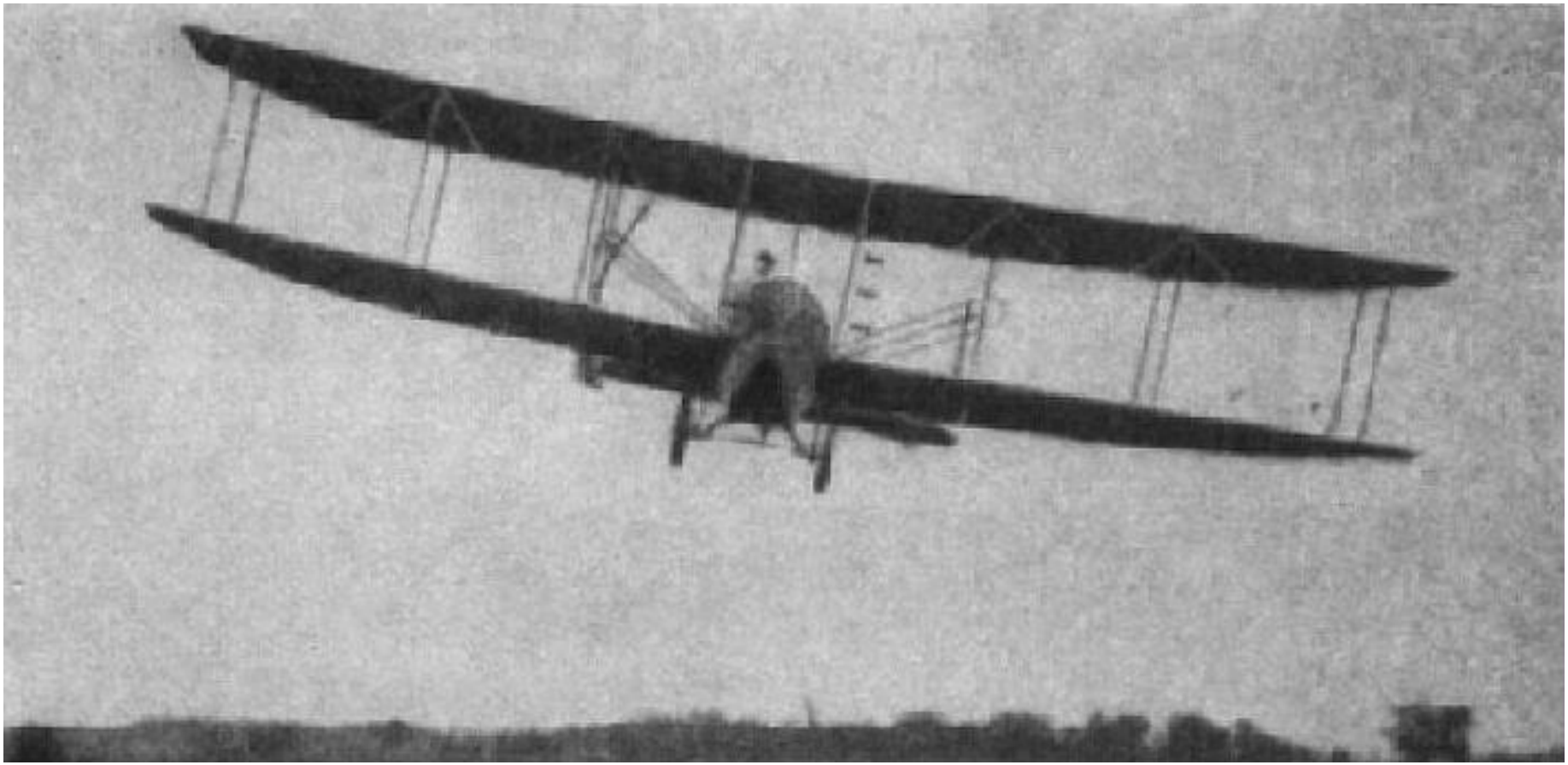
1921 Armeleder 2 Ton

1929 Ford

1903 Wright Flyer



1914 Wright Model H

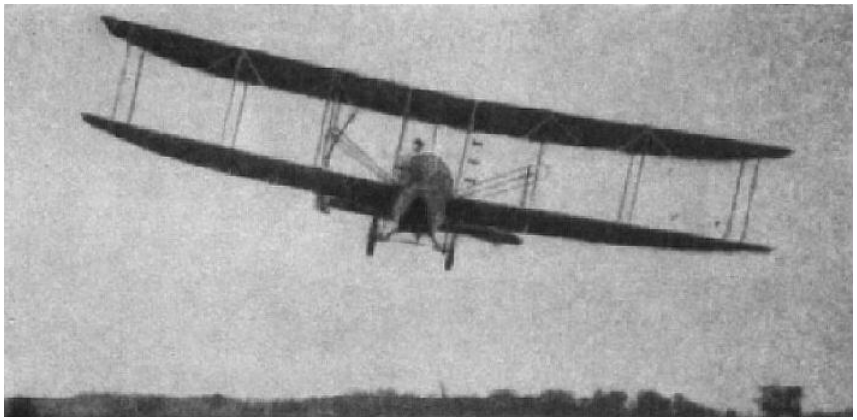


1937 Grumman Duck

1939 B-24 Liberator

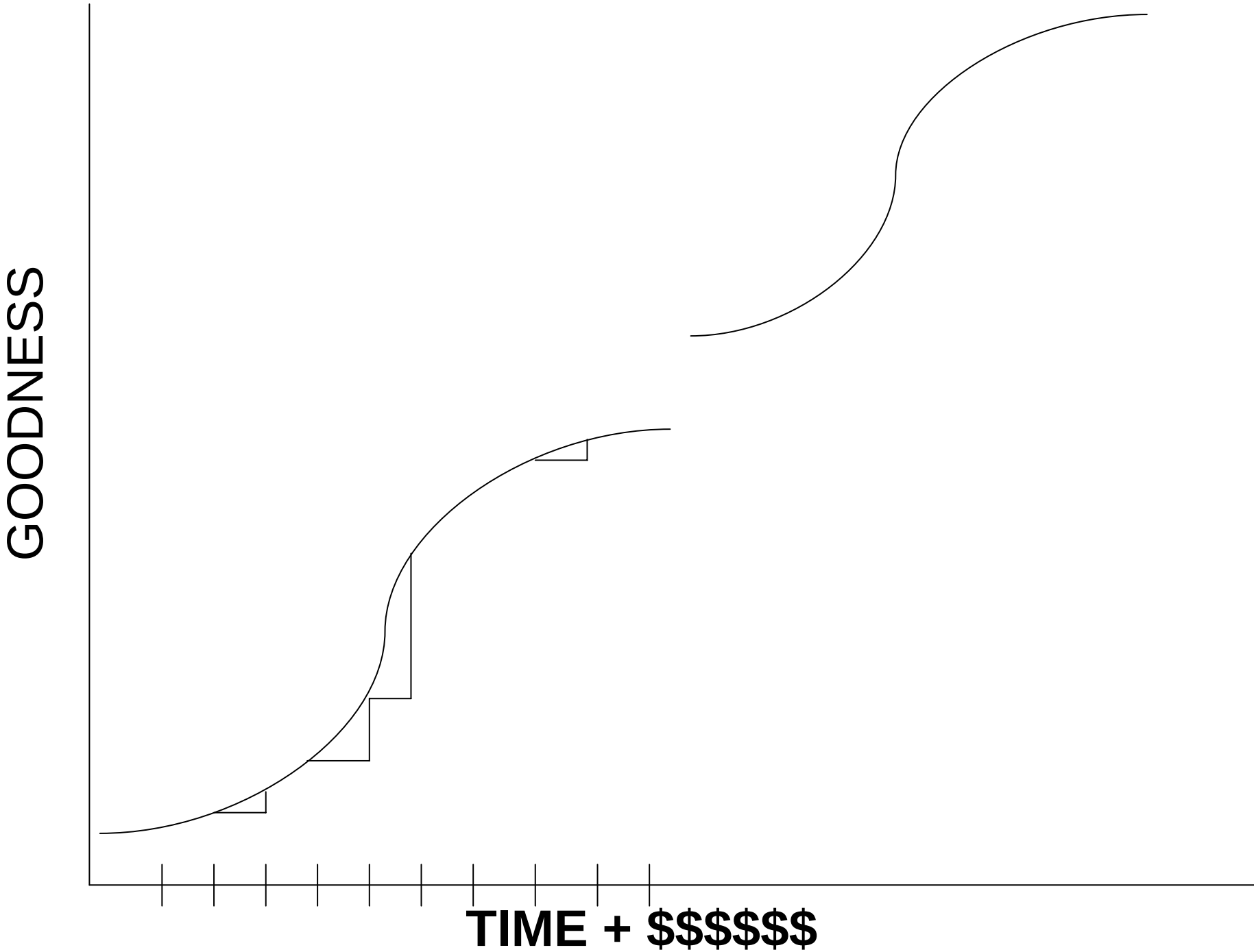
1962 A-12 “OXCART”

1914-1939-1962



25 Years

23 Years


GOODNESS
TIME + $$$$$$

DoDR&E 2007 Strategic Plan

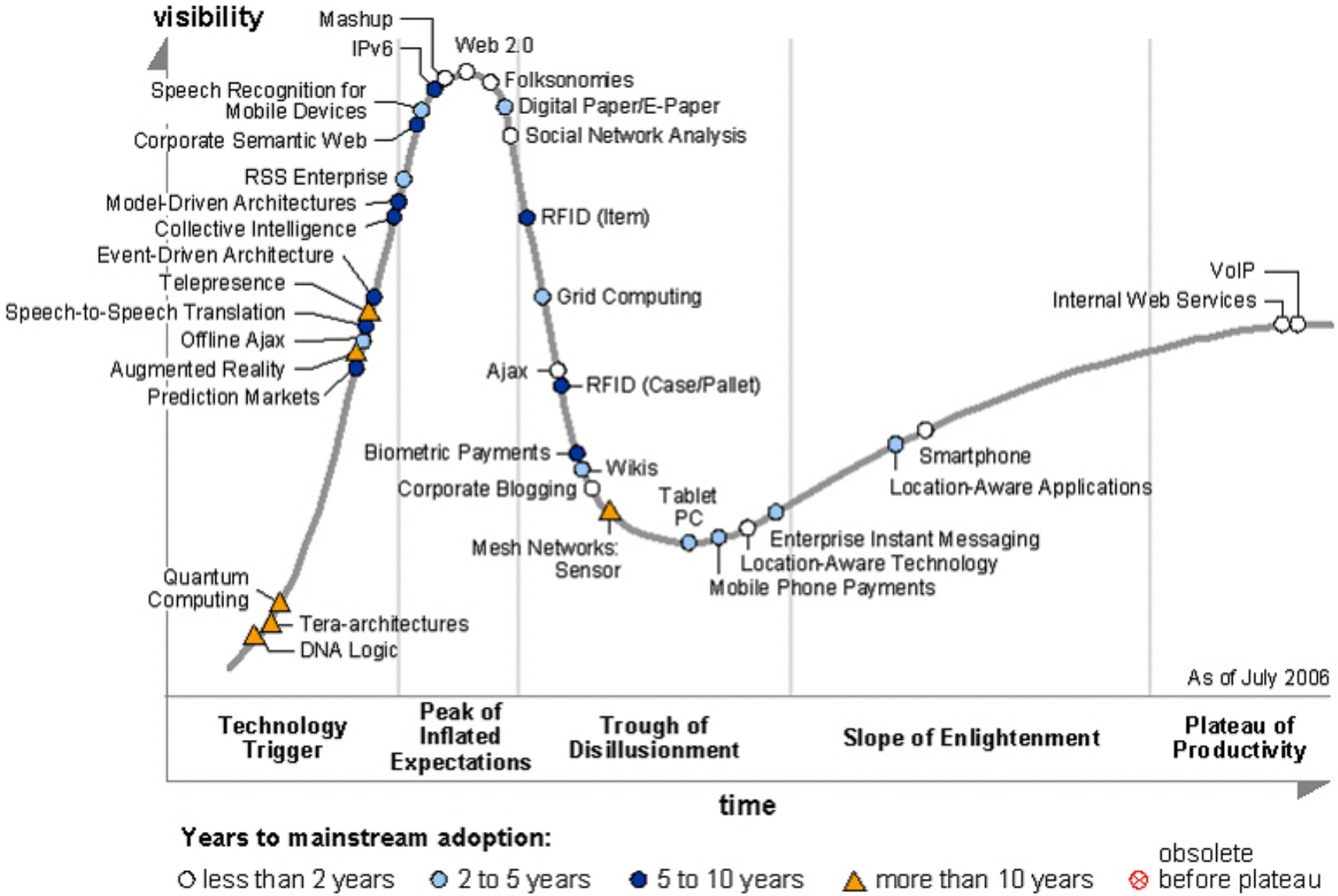
- **Biometrics & Bio-inspired Technologies**
- **Nanotechnology**
- **Information Technologies**
- **Persistent Surveillance Technologies**
- **Networks & Communications**
- **Software Research**
- **Organization, Fusion, & Mining Data**
- **Human, Social, Cultural, & Behavioral Modeling**
- **Cognitive Enhancements**
- **Casualty Care & Human Performance Optimization**
- **Advanced Materials**
- **Advanced Electronics**
- **Energy & Power Technologies**
- **Alternative Fuels & Energy Sources**
- **Energetic Materials, Rocket Propellants , & Explosives**
- **Directed Energy Technologies**
- **Hyperspectral Sensors**
- **Radar**
- **Autonomous Systems Technologies**
- **Robotics**
- **Manufacturing Technologies**
- - Affordability & Producibility
- - Agile Fabrication
- **Combating Weapons of Mass Destruction Technologies**
- **Large Data Set Analysis Tools**

Capabilities \ Technologies	Biometrics	Nanotechnology	Info Technology	Surveillance Technologies	Networks & Communications	Software Research	Organization, Fusion, & Mining Data	Human, Social Cult. & Behavioral Modeling	Cognitive Enhancement	Casualty Care & Human Performance Ops.	Advanced Materials	Advanced Electronics	Energy & Power Technologies	Alternate Fuels & Energy Sources	Energetic Materials Rocket Propisn. & Exp.	Directed Energy Technology	Hyperspectral Sensors	Radar	Autonomous Systems	Robotics	Manufacturing Technology	Combating WMD	Data Set Analysis
Persistent Surveillance*	●	●	●	●							●	●	●				●	●	●	●	●	●	●
Locate, Tag, & Track Terrorists & WMD*	●	●	●	●			●	●	●			●	●				●	●	●	●	●	●	●
Fuse Intelligence Information*			●		●	●	●	●	●													●	●
Improved Language & Cultural Awareness*			●				●	●	●													●	●
Human Intelligence (HUMINT)*		●	●		●		●	●	●	●												●	●
Tailored Lethality with Non-Lethal Options*				●							●		●		●	●				●	●		
Urban Warfare*	●	●	●	●	●			●	●		●	●	●				●	●	●	●	●	●	●
Prompt Global Strike*		●	●	●	●						●	●	●	●	●	●	●	●		●	●	●	
Small Unit & Riverine Warfare*		●	●	●	●			●	●				●	●	●		●	●		●	●		
Protect Against IEDs	●		●	●				●	●	●	●	●	●			●	●	●	●	●	●		
Interoperable, Joint Command & Control*		●	●		●	●			●			●	●								●	●	
Enhanced Air & Maritime Awareness		●	●	●	●		●	●	●			●	●	●			●	●	●	●	●	●	●
Consequence Management	●		●		●			●	●	●			●	●					●			●	●
Broad Spectrum Medical Countermeasures		●	●																		●	●	
Air & Missile Defense*		●	●	●	●							●	●	●	●	●		●	●	●	●	●	
Large Vessel Stop/Maritime Interdict Ops*			●	●	●		●		●				●			●	●	●		●	●	●	
Secure Broadband Communications*		●	●		●	●	●					●	●								●		
Air Dominance*		●	●	●	●				●		●	●	●	●	●	●		●		●	●		
Undersea Warfare*		●	●	●	●						●	●	●	●	●					●	●		
Cyberspace Shaping/Defense*		●	●			●	●	●				●	●								●		
Rapid Deployment*			●		●		●	●	●	●	●		●	●	●	●	●	●		●			●
Survivable Joint Command & Control*		●	●		●	●						●	●							●	●	●	
Stand-off Detection of Fissile Materials*	●	●	●	●			●				●								●	●	●	●	
Stand-off Detection of Chem & Bio Agents*	●	●	●	●			●				●								●	●	●	●	
Nuclear & Enhanced High Explosive Mats.		●													●						●		
Capabilities to "Render Safe" WMD*	●		●				●		●				●		●	●				●	●	●	
EMP Shielding of Critical & Vulnerable Sys*		●									●	●									●		
Responsive, Affordable Space Access		●									●	●	●	●	●						●		

*Indicates ODR Designated Capability

Granger HYPE Cycle

Granger HYPE Cycle



Net Enabled Weapons

PRESENTATION TO:

Precision Strike Technology Symposium

PRESENTED BY:

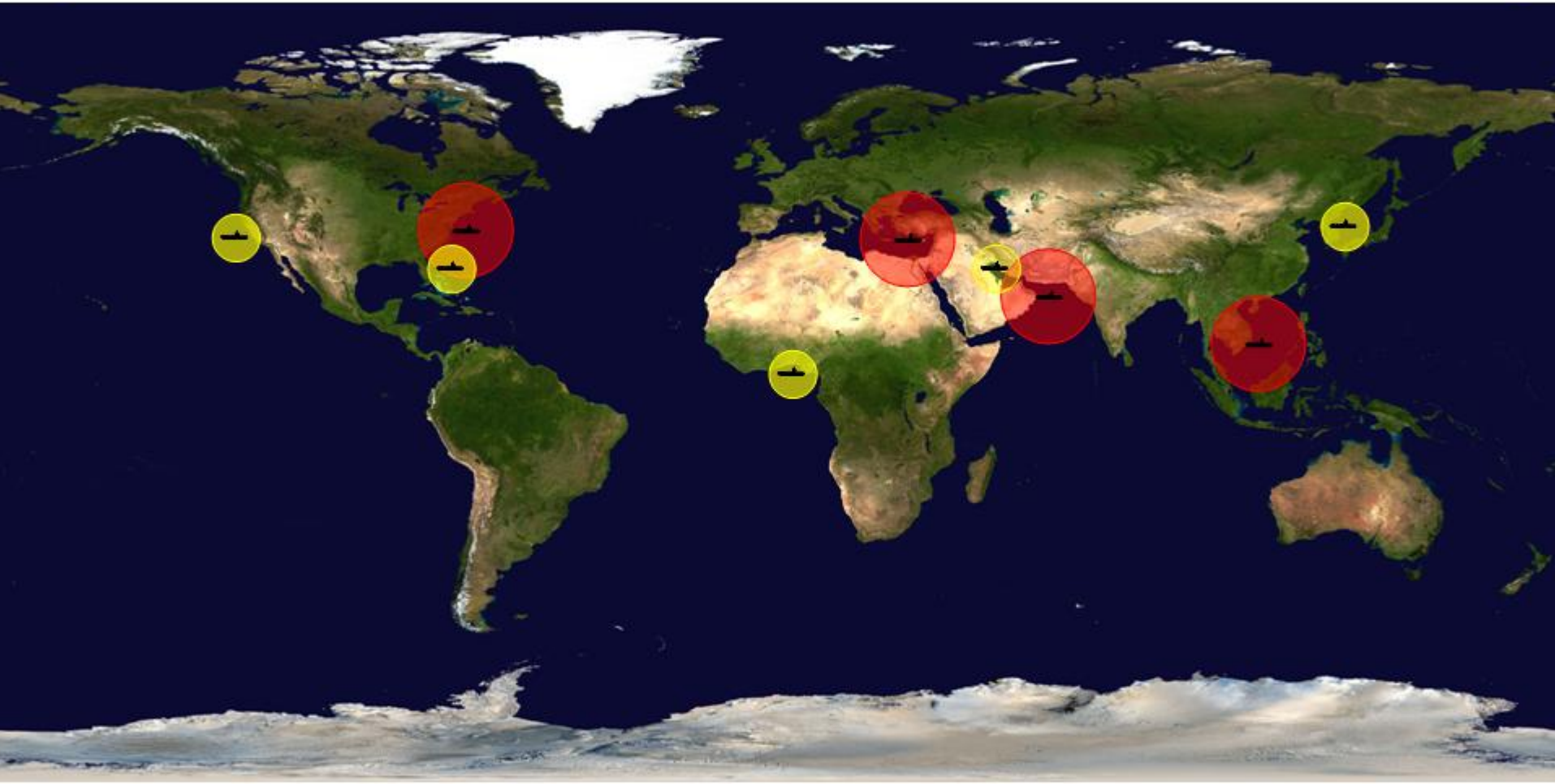
CAPT Mat Winter

Program Manager, Precision Strike Weapons

24 October 2007

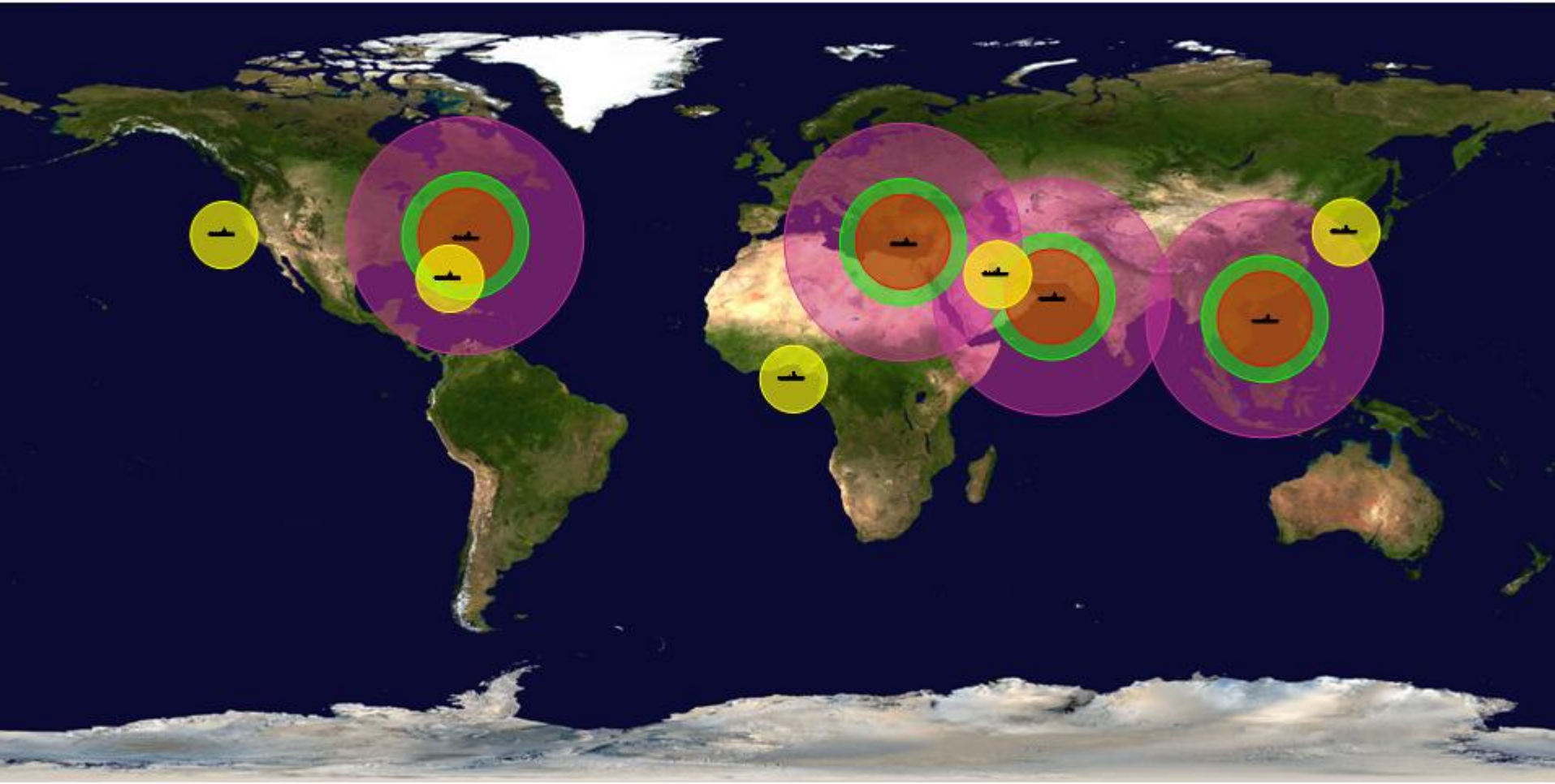
mathias.winter@navy.mil

Reach of Naval Aviation Today



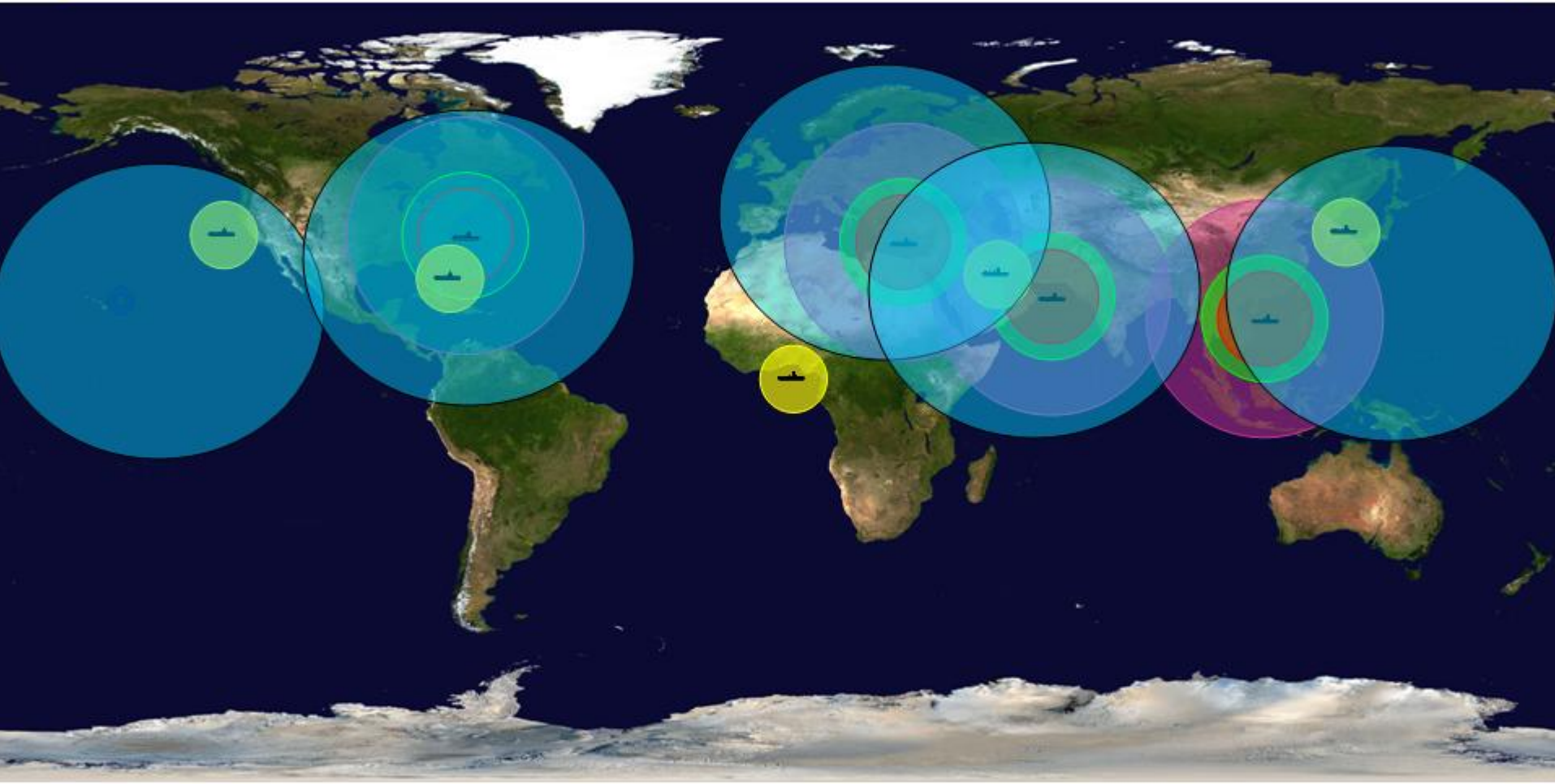
CARRIERS AND THEIR AIR WINGS,
DELIVERING TOTAL WARFIGHTING CAPABILITY TODAY

Reach of Naval Aviation Tomorrow



TRANSFORMATIONAL WEAPON SYSTEMS PROVIDE UNPARALLELED RANGE AND STRIKING POWER

Reach of Naval Aviation Future Vision



UNMANNED AVIATION SYSTEMS PROVIDE ADDITIONAL STRIKING POWER

Strike Weapons Today and Tomorrow

Today	Tomorrow
Direct Attack	
Laser Guided Bomb (LGB)	Dual Mode LGB
Joint Direct Attack Munition (JDAM)	Laser JDAM
BLU-126/B LCDB	BLU-126/B LCDB
LGB DMLGB JDAM Maverick	Direct Attack Moving Target Capability (Retrofit GBU-12 and GBU-38)
Medium Range Standoff	
Harpoon	Harpoon Block III
JSOW-C	JSOW-C1
	SDB-II
Long Range Standoff	
SLAM-ER	SLAM-ER

Today

JDAM Family of Weapons

Laser Guided Bomb

GBU-31(V)2/B

GBU-32/B

GBU-38/B

Low Collateral Damage Bomb (BLU-126/B)

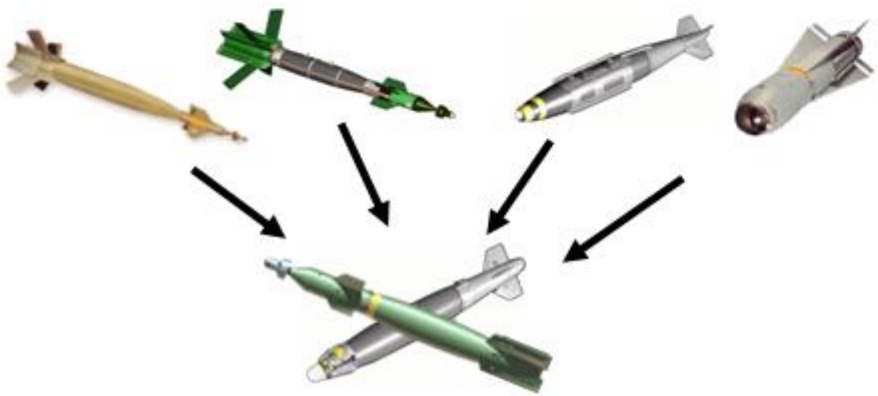
PBXN-109

Inert

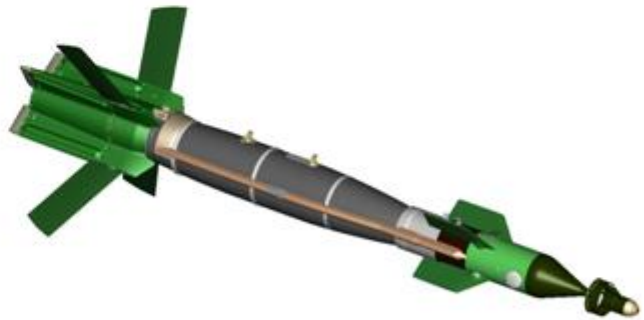
Felt Pad/Air Gap

Tomorrow

Direct Attack Moving Target Capability

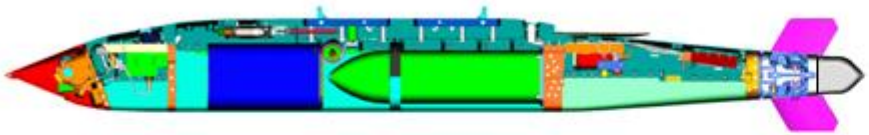


Dual Mode Laser Guided Bomb GBU-12F/B)



Laser JDAM GBU-54)

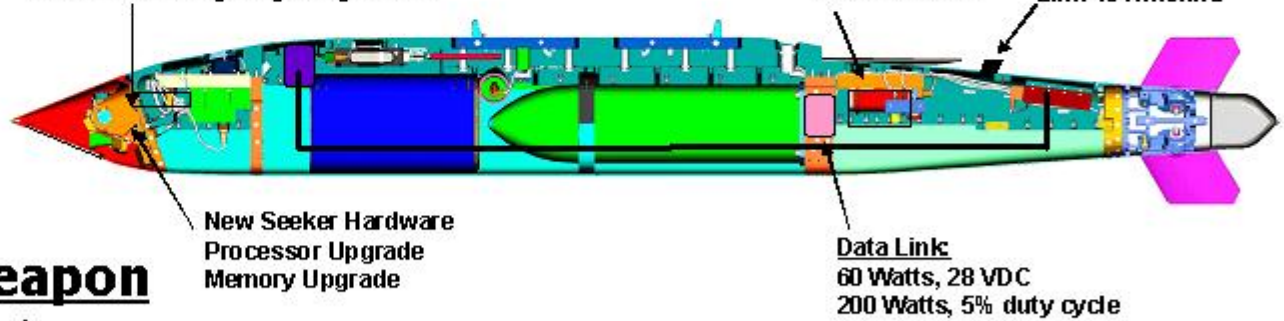
Today



Joint Standoff Weapon
AGM-154C

Tomorrow

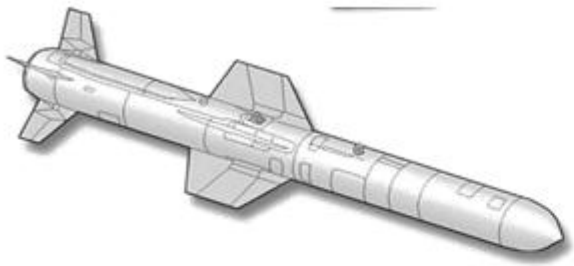
AGM-154C-1



Network Enabled Weapon

- Link 16 Datalink communication
- In Flight Target Updates
- Moving Maritime Targets

Today



Harpoon

Tomorrow

Harpoon Block III

Network Enabled Weapon

- Link 16 Datalink communication
- In Flight Target Updates
- Moving Maritime Targets

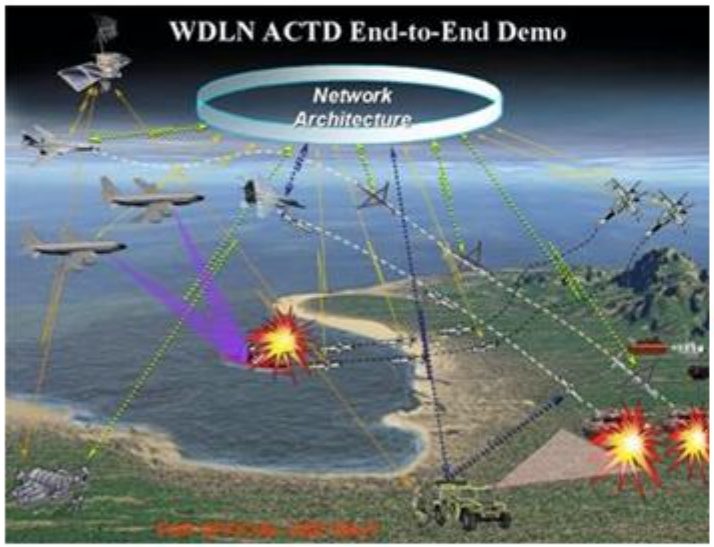
Today

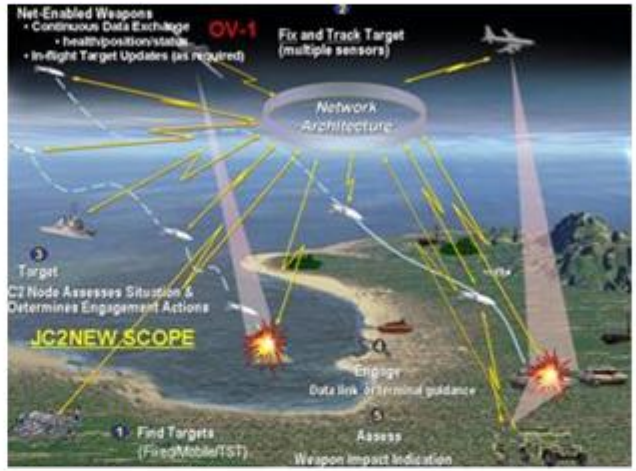
Standoff Land Attack Missile – Expanded Response

Tomorrow

Net-Enabled Weapons Initiatives and Transition Paths

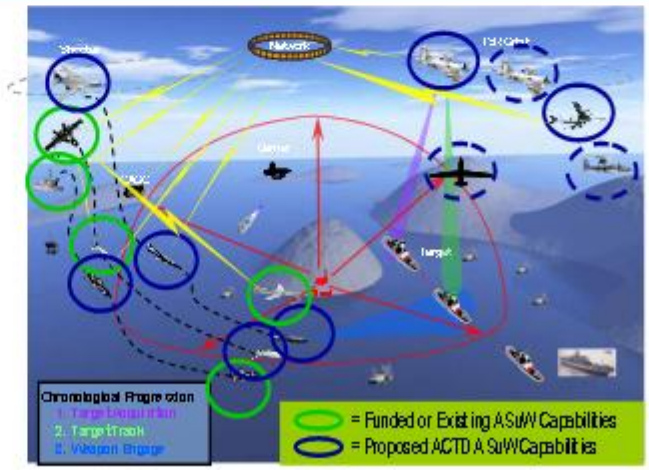
WDLN ACTD





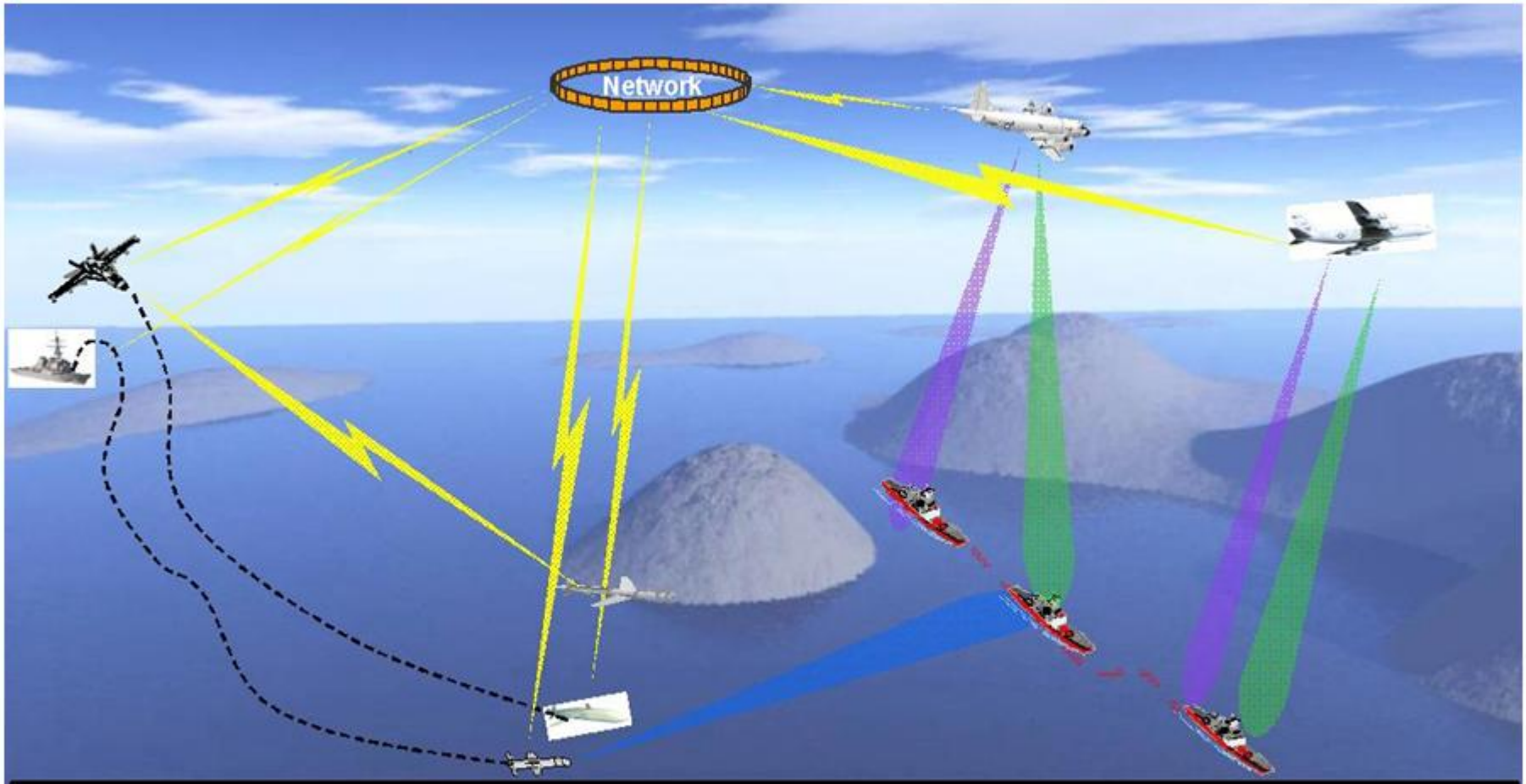
JC2NEW JT&E

CONOPS, CONEMP, TTP REFINEMENT



JSuW JCTD

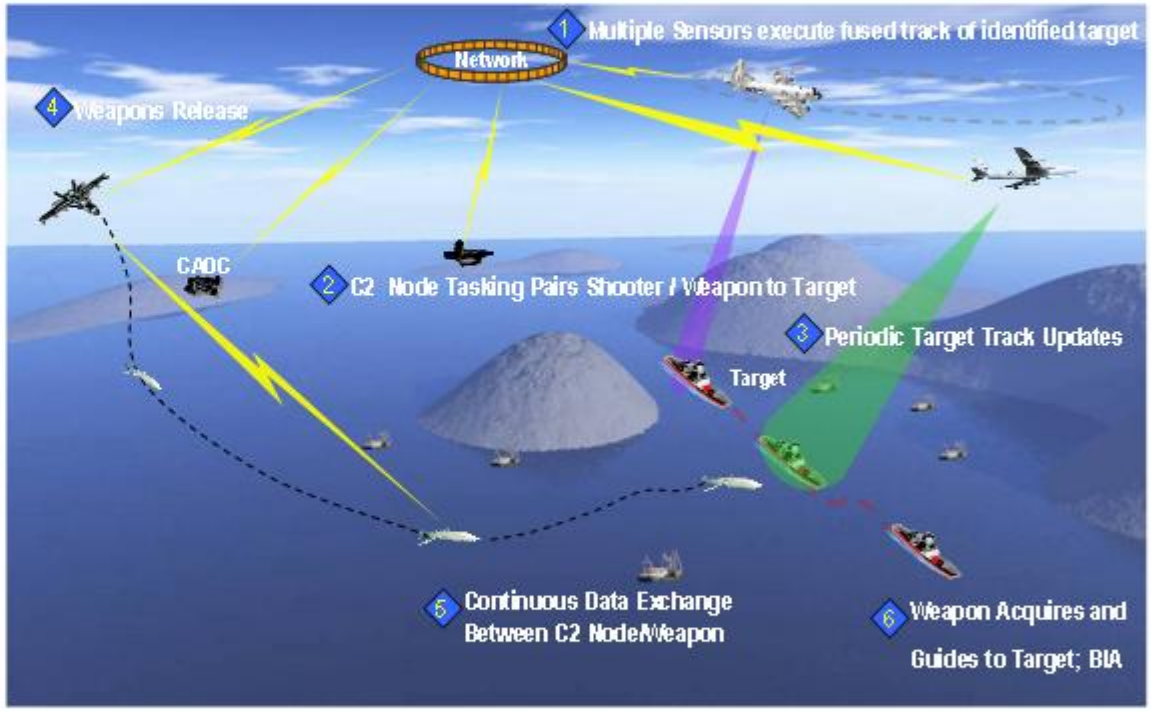
Joint Surface Warfare (JSuW)
Joint Capability Technology Demonstration
(FY 2007-2010)



- JSTARS / LSRS targeting (3rd party targeting source with shooter retaining admin control)
- FA-18 shooter / Surface Harpoon shooter simulated
- JSOW-C-1 / Harpoon III / SLAM-ER (IFTUs through FA-18 / AWW-13 pod to weapon)

Net Enabled Weapons (NEW) Message Set

- FY05 Weapon Data Link Network Advanced Capability Technology Demonstration
- Resulted in MIL-STD-6016C Interface Change Proposal
- J-11 series NEW messages
  - Latitude, longitude
    - TLE size
    - TLE ellipsoid orientation
    - Time stamp of target detection
  - Elevations
  - Track quality
  - Velocity
  - GPS time
  - Track Number
  - Retarget
  - Abort
  - In-flight tracking
- NEW Link 16 network
  - Design appropriate network to support the mission

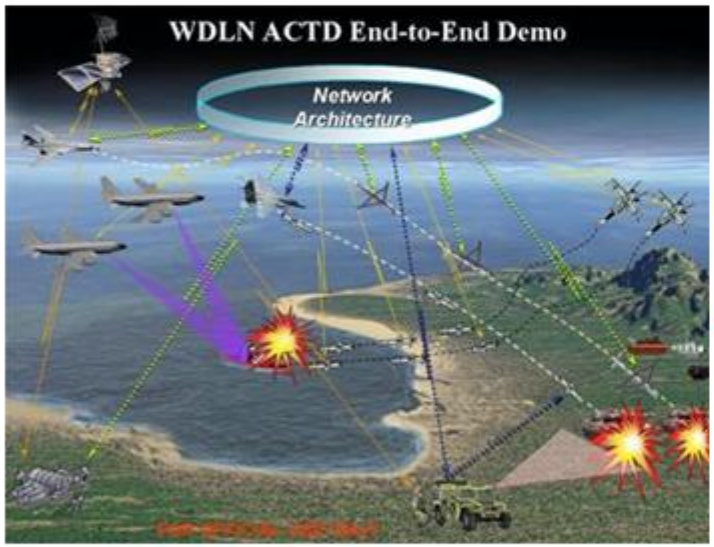


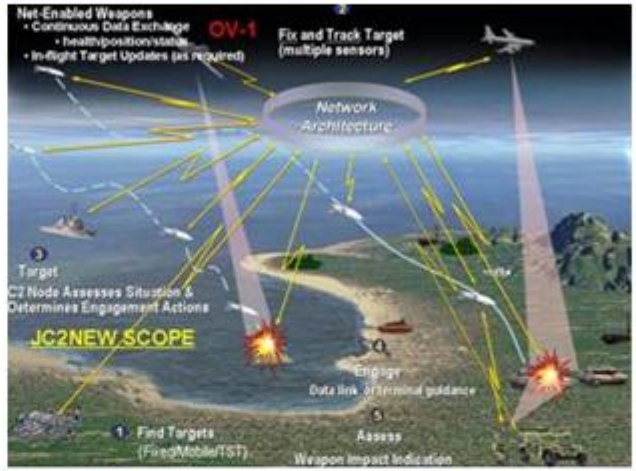
JSuW JCTD Summary

- **WDLN ACTD demonstrated NEW concept**
- **Current PORs implementing WDLN message set**
  - JSTARS, P-3 LSRS, F/A-18
  - JSOW-C-1, Harpoon Block III
- **Operational Need**
  - Current SuW targeting limited at range
  - Adverse weather capability limited
  - Most current SuW involves direct attack
- **Desired Capability**
  - All weather, stand-off SuW
  - FY-10 MUA

Net-Enabled Weapons Summary

WDLN ACTD





JC2NEW JT&E

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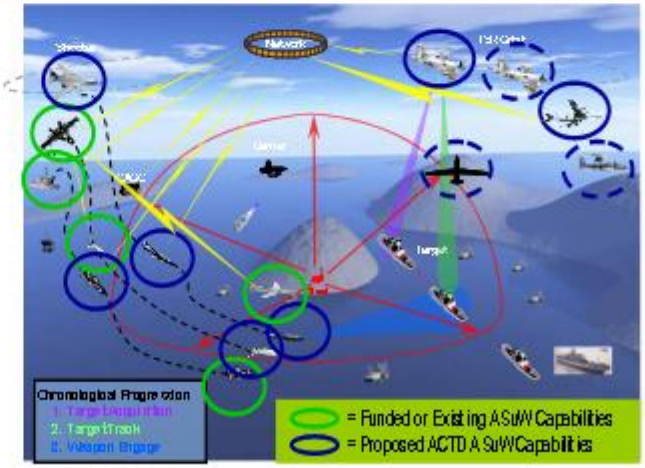

JSuW JCTD